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Gerald S. Craig
Professor of Natural Sciences
Teachers College, Columbia University

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CLARENCE M. PRUITT, EDITOR

*University of Tampa
Tampa, Florida*

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SCIENCE EDUCATION

VOLUME 40

APRIL, 1956

NUMBER 3

CHILDREN AND SCIENCE *

GERALD S. CRAIG

Teachers College, Columbia University, New York, New York

CHILDREN ARE GREATER THAN SCIENCE. Science has its importance in elementary education only as it serves boys and girls and through them the democracies of which they are a part.

It is so easy for specialists to become enamored with their own special fields and to lose sight of the learner in teaching the subjects. But the elementary school with its great purpose is no place for the specialist to "strut" his specialization. Rather it is an institution in which a specialist must walk in true humility in that he has been permitted to live with, to teach, and to learn with children, the adults of tomorrow.

The question in the study of the curriculum can never be what is "best" for science, rather the question must be what is "best" for children. The teacher must recognize always that children are greater than science.

So frequently we hear science personified in statements, such as, "science does this"—as if science were a being, a personality. But science is inanimate. Science does nothing in and of itself. It is man who does things with science. Science decides nothing but man makes decisions, although he may utilize the findings and techniques of science in reaching decisions. Science is the product of mankind,—mankind is not

the product of science, although man's ways of living will in turn be influenced by the science he himself has developed. It is good for us as elementary school workers to realize that modern science is the result of the work of boys and girls—grownup boys and girls of the past and present.

SCIENCE LEARNING STARTS AT BIRTH

The Developmental Point of View. Science in elementary education should be considered completely from a developmental point of view that is sound with regard to the fundamental nature of children and that of science. The fundamental characteristic that is common to both children and science is that both are actively involved in interpreting the objects and events of the environment. For science may be defined as man's attempt to interpret and to operate with the materials and forces of the universe that surrounds him. Modern science grew out of this age-old endeavor of the human race. The individual, whether child or adult, attempts from birth to death to orient himself to the forces of his environment.

This indicates that the historic function of science—that of exploration or interpretation of the events of the environment—is in keeping with the dynamic drives of children. Teaching and learning in the field of science can be consistent with the nature of children.

A Child Interprets His World—Science

* An address delivered at a joint conference of the National Council for Elementary Science and Association of Childhood Education International at Kansas City, Missouri, on April 16, 1955.

Is Man's Attempt to Interpret the Universe. The word "interpretation" is a more satisfactory and more inclusive term for describing what goes on inside a child and within the field of science than the words "explanation" or "understanding." Neither children nor science have final explanations or understandings of the happenings in the universe. But both children and science are involved in the active process of interpreting the physical world. Children use their sensory capacities and intelligence in making their interpretations and science is characterized by a continual revision of content and techniques. Interpretation is a dynamic term which allows for growth and development and is in keeping with the nature of active and growing children.

It is also a term more in keeping, as we shall see later, with the modern concept of science as contrasted with the more traditional classical and absolute view of knowledge.

From this developmental point of view of science education, children do not come to school for the first time at zero in science learning. They have already reacted to gravity, energy, lightning, thunder, darkness, light, weather, and a host of other scientific phenomena. They may bring with them misconceptions, superstitions and fears and become a liability to society, or they may come to school with a good attitude for learning and ready for the development of intelligent resourceful behavior. The fact that a child lives in a universe that stimulates him to interact with it and that he is surrounded by other individuals with interpretations which they force upon him causes him to form interpretations in the pre-school years.

Science learning as defined in this paper begins in the cradle. As a child begins to separate himself from his environment he begins to develop learnings of various kinds. It will be worth while for us as teachers and parents to realize the significance of these early experiences. These learnings are the beginning of science education for a child. It can be seen from this

that from a developmental point of view the parent may be thought of as a child's first teacher of science.

By the time a child begins the elementary school, it is quite likely that he has gained certain concepts of roughness, smoothness, sharpness, lightness, heaviness, shininess, dullness, brightness, darkness, speed, acceleration, inertia, firmness, stability, instability, transparency, opaqueness, translucency, hardness, softness and many other characteristics found in his environment. He has beginnings of an understanding of these concepts which are in reality abstractions. This is not to say he has learned all there is to learn about these abstractions but what he has learned, associated as these concepts are with his experiences, is most fundamental.

Density is not an easy concept to understand in its total meaning. Yet children may secure a concept from experiences which may be a working concept in that they may recognize through kinesthetic senses that some things are heavy for their size, while others are light. A piece of balsa wood used in building a toy plane may be very light for its size while a hammer may be heavy for its size.

The early learnings in science according to the developmental concept is a result of the natural human drives for adjustment. Much of the learning about the environment may be associated with what the adult usually calls play. But much of this so-called play by a child is a learning process through manipulation of objects about him.

We as adults are likely to overlook the significant learning about the environment that goes on in the first few months of a child's life. Learning from experience that water can be poured from a cup or that crawling over the edge of the bed will result in a fall, can be learning experiences with the earth's gravitational field, or again, attempts to catch sun rays and smoke may initiate children into a beginning awareness in the variety of things in his environment. Words may follow weeks or months later

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but the words have more meaning if there is association with experiences.

A mother in Ohio keeping anecdotal records of her son Jonathan's learnings about his environment relates that at fourteen months he tried to catch smoke and sunlight. He chased bubbles about the room and shrieked with anger when he tried to pick them up and they burst and disappeared. The emotion displayed by this fourteen months old child reveals there was learning involved.

Jennie, two and one half years old, in playing by herself fell off the sofa. She was not hurt and crawled back onto the sofa to repeat the experience. She did this a number of times, each time making a cry of pleasure. She seemed to be enjoying these experiences. She then looked around for another place to fall from and decided on the arms of the sofa which were higher than the sofa when she was stopped by her mother. Here we have play on the part of a small child with the earth's gravitational field of force. The kind of experience Jennie had is so universal that the reader might well question it being listed here as involving learning in science. We prefer to call the kind of meanings a young child may secure from such experiences as experiential meanings. The development of concepts of the environment may begin in the experiences in handling objects, in feeling, in holding, in smelling, in poking one's finger into it, in trying to grasp it, to pull it apart, and the many other activities observed in babies, young children and for that matter, all of us. The point made here is that the experiential learnings begin before there are words to express them and form a very basic structure for learning concepts at later levels. And we believe it is important in the home and at all levels, especially the nursery-school, kindergarten, and primary levels, for every child to have rich experiences with natural phenomena. The learning can be experiential, that is, based on experience, regardless of whether words are utilized to express the concept or not.

A DYNAMIC PSYCHOLOGY OF SCIENCE EDUCATION

A discussion of the teaching of elementary science, therefore, naturally starts with two elements—a child and the environment. A child lives in the environment. In a sense, his environment begins with his skin, coming so close that it surrounds him continuously from birth to death. In another sense, the environment continuously encroaches upon the individual and there is constant interchange of material between the two, otherwise death results. The environment has meaning for the individual, and the kind of meaning it possesses for him has much to do with the kind of individual he is. If he thinks his environment is filled with hostile spirits of which he is afraid, and a set of freakish principles such as lucky and unlucky numbers, and other superstitions, then he is likely to be one whose mental potentialities are stunted. If on the other hand, the individual sees his environment as something that can be studied and intelligently utilized, he will have a more constructive outlook upon life. Man's growth, both individually and socially is limited by the kind of meaning he has of his environment.

A child interacts with the environment whether he receives a good education or not. A definite task of the school is to guide this interaction in the direction of those meanings which are beneficial to the individual and to society. The beneficial meanings are those which are in keeping with the most accurate information that man has at any one time. This latter is science.

Many teachers of children find it useful to accept a point of view of dynamic psychology for understanding children. Their ideas of children may be stated simply in such words as these: "A child lives in a dynamic universe which is new to him. He is challenged by his many experiences. This universe is filled with a great variety of objects. He is impressed by the events (phenomena) small and large occurring about him, such as rusting, decay, rain,

weathering rocks, electrical shocks, thunder, wind, falling objects, birth and death. He finds himself in normal circumstances tremendously stimulated and turns naturally to exploring and learning."

A young child is naturally egocentric. He is not to be condemned for being so, for his learning must go on inside himself. His egocentricity grows out of his great potentialities for ceaseless drive and for adjustment to his environment and to himself. His adjustment is a result of his own interpretations. As a result of the great drives and yearnings, he feels inside himself a whole gamut of emotions which are to him discoveries about himself. He may display grief, irritability, anger, restlessness, impatience, and disappointment. Although such expressions are not to be condoned or encouraged in children, they are not to be considered in themselves evil, for out of these emotional drives have come and will come many of the great constructive developments of mankind, such as democracy, better living conditions, religious freedoms, and improved health.

SCIENCE IS A RESULT OF HUMAN DRIVES

In a very real sense then, we might say that the potentialities of science are inside human beings. To make it more personal we may think of these potentialities as being in such human beings as ourselves—teachers and children in the classroom. This is true because science has grown out of a tremendous urge on the part of mankind through the long centuries to understand the universe.

According to the developmental point of view, the origin of science is in man's distant past. An implication of this for teachers in the elementary school is that science need not be thought of as something foreign to them or to the children they teach. Science as we know it today, with its discoveries and inventions, is the result of urges in men and women through the ages. We can see these same urges in children as they follow their natural drives

and as they attempt to secure adjustment and equilibrium in a dynamic universe. They use the senses of smelling, tasting, feeling, seeing, and hearing, the kinesthetic sense, imagination, curiosity, energy, irritability, restlessness, play, response to external conditions, and other partly understood drives deep within their natures to project themselves into the areas of the environment. They depend upon impulse, fancy, creative activities, and logical thinking just as their ancestors did.

From the developmental point of view not all of science is difficult. On the contrary, from this point of view science is part of the earliest learnings of children. Furthermore, the technical, vocational, and specialized aspects of science have no function in elementary education. Elementary science is closely related to the experiences of children and to the kind of thinking they can do, so that teachers need have no fear of science. A teacher can learn the science that is needed while teaching at any level in the elementary school.

The fear of science felt by some adults is not usually found in children. The adult may have been conditioned to a dislike of science in part by previous contacts with science instruction at high school and college levels, whereas children, having felt no such conditioning, are still following their natural impulses. Teachers can free themselves from their negative reactions if they will attempt to see the environment and science through the eyes of children. Encouraging children in a classroom to express themselves freely without fear of being humiliated about their ideas of natural events has assisted many teachers to understand children and at the same time to gain a new look at the world for themselves.

Variation in Abilities in Science. Many children display a somewhat passive attitude toward any attempt at interpreting the environment. They may show no curiosity or interest in investigation, or they may refuse to participate in group discussion. In some cases the individual child may remain passive because he recognizes that

his activity in such directions would not compare favorably with that of his fellows. The home life, in other cases, may serve to repress interest and curiosity.

Sara, eight years old, had remained in a group of children for two years. In her class there were a large number of boys and girls who were very much interested in studying science. For over a year and a half, Sara participated so little that no one could have told whether she was interested or not. One day she came into the discussion with a naturalness and eagerness which amazed the observers. She continued to participate at intervals. The wise teacher made no comment about Sara's long period of silence. Sara, feeling no embarrassment, from either praise or criticism, kept on with her new interest. No pressure had been exerted upon her during her long period of silence. Those who observed were impressed with the quality of her thinking. Apparently there had been growth along with the others, although there had been little overt behavior on which she she could have been evaluated.

Teachers should expect to find differences in the ways in which children respond to science and should not strive to make the reactions identical. Some children are interested in physical and biological phenomena and can exercise leadership in science activities; others will display little or no leadership. Teachers can utilize the natural leadership in the class for creative class discussion and planning, performance of original experiments, and the interpretation of content in reading material. A teacher can also encourage children who are superior to pursue their special interests. However, the fact that some children can have individual science interests does not indicate that every member of the class must have them. Teachers must expect individual differences in science, for the interplay of inheritance and environment makes for biological differences. Variation is a characteristic of life and adds to the richness of the characteristics of human beings and of all living things. The ele-

mentary school must respect this fundamental aspect of human beings.

Children having special abilities in science should be guided to share their knowledge and skills with others in a cooperative fashion. The talented child may need to know how to recognize merits in others. A teacher may cater so much to the superior child that undemocratic behavior is promoted. The elementary school has a contribution to make to all and we would like to feel all children are equally important in the elementary school, regardless of their future position in society.

There have been cases when a child who expresses himself very infrequently is the one who is doing the most profound thinking. The spirit of the discussion should be such as to encourage such a child to share his thinking with his fellows.

Children vary in the length of time they can concentrate on the kind of activities required in science such as investigating, experimenting, discussing, developing explanations and reading for information. And there is no reason why the teacher should attempt to level off the group. Individual differences can be considered and certain children can be encouraged to assume responsibility for the kind of activity that seems to be beneficial to them. However in the interest of democracy, because of the vital nature of science in modern life, there should be some teaching-learning activities that are common for all the children in a class. The significance of this can be better understood in relation to the purpose of the elementary school in a democracy. Individuals who can do more than others through their own individual enterprise, should be encouraged to do so; however, there should be some reporting back whenever advisable to the entire group.

Variation in Behavior in a Child. Children vary from time to time in kinds of behavior. A six-year-old disappeared from his family group one day. From somewhere in the basement came a light hammering. In approximately an hour, Jimmie emerged from the basement and exhibited four

blocks of wood, fastened together by nails in such a way as to represent a tug boat and three barges. This child had made a brief visit during the previous summer to a busy sea coast harbor. Both this visit and a book about boats seem to have stimulated a relatively long period (an hour) of concentration. The same child had been most restless about many activities on the preceding afternoon, exhibiting little ability to concentrate on a single project more than a few minutes at a time. Purpose, energy, imagination, and other drives can alter children in their abilities to concentrate from moment to moment.

CHILDREN ARE MAKING INTERPRETATIONS CONTINUALLY

It is not always the wording of an inquiry that reveals the child's quality of thought. Children nine years of age engaged in a heated discussion about where cats came from. The teacher said, "From mother cats" but the children said, "Where do mother cats come from?" and "Grandmother cats?" and "Great-grandmother cats?" and so on. The questions clearly did not grow out of facetiousness but rather a desire to push back to origins, an interest frequently displayed by children. This question could have involved reproduction of a species; then again it could have involved tracing back to the origin of cats from their wild forebears.

In teaching it should be kept in mind that the experiences a child has had greatly color his explanations of events. Out of the experiences he builds a working picture which he may use in explaining a new experience. Even his imagination grows out of his experience. In most cases what may seem fantastic to the adult is drawn out of interpretations of experiences of the past.

The fourteen-months-old child, Jonathan, expresses anger when the bubble bursts. Perhaps to him the bubble is a ball and he expects to find the bubbles having characteristics like other balls. Other balls have been handled by Jonathan, now why

shouldn't the bubble be handled in the same way. Navarra¹ in his study of a three-year-old calls this attempt of children to postulate on past experiences, "expectancy." In Jonathan's case, like many experiences of children and adults, too, there is a second phenomenon involved. The second phenomenon is inside Jonathan in the form of an emotion. The emotional world inside the child is as much a part of a world of discovery for him, as the world of material and energy that surrounds him. Who hasn't been amazed at some time or other by the world of emotions.

It could be well for the parent to arrange for Jonathan to have other experiences with bubbles. Perhaps by repetition he will learn to accept the fact that not all round objects are like his plastic and rubber balls. Here we would find modification of the original interpretation that Jonathan made. He learns probably with almost no words that some things do not burst in his hand but other things do, such as bubbles. The learning is experiential in character, in his special senses of seeing and feeling.

Children Repeat Experiences. Repetition of an experience is important in learning. Children's tendency to repeat over and over the same thing, such as shouting down a hallway, striking an object to make a sound, reinforces learning. Repetition allows time, so important in learning. This allows a fuller penetration of the experience and may reinforce the memory.

Since the world is new to children, an adult can sometimes understand children better by studying his own reactions to something which is quite novel to him. The adult may have seen a sight that is entirely novel to him, perhaps in his travels. He looks and looks. He may use some of the other senses such as hearing, smell, and touch. He may remain a day or so longer and he repeats his observations. He seems to drink up the special features of the place

¹ Navarra, John Gabriel. *The Development of Scientific Concepts in a Young Child—A Case Study*. New York, Bureau of Publications, Teachers College, Columbia University, 1955.

or of the experience if it has been especially challenging to him. Even if the novel experience has had frightening aspects, he may relive it in his memories.

Children will perform certain activities over and over. They repeat an action. They repeat it again. Then they go off to some other activity. But children frequently return to the original activity and they may repeat the experience again and again.

Repetition of an experience with natural phenomena that involves a sequence of events has the elements of continuity, suspense, and even some drama. There is much of the dramatic and challenging in science. By observing children's own spontaneous activities, particularly the kind of thing they tend to repeat or talk over, while studying science, a teacher can learn much about what has challenge for children.

In this type of repetition a child is employing spontaneously some of the principles of good concept formation. Repetition of experience reinforces the learning. Repetition may provide a child with opportunity to build a better mental image or working picture of a sequence of events.

Repetition may provide opportunities for a child to utilize more fully additional senses. The entire experience may utilize one or more of the special senses, such as seeing, smelling, tasting, hearing, feeling as well as kinesthetic senses.

Emotions in Interpretations. Children may feel some emotions in the process of repetition. In some cases children and adults may be exploring their own emotional capacity more or less subconsciously in the course of a repetition of an experience or in the prolongation of an experience.

The emotional aspect of learning in science has been neglected in education. Science, although objective and realistic within itself, has had emotional impacts on society and the individual at many angles. The emotions engendered by science are not all negative. As a matter of fact science as an activity of man has had a most wholesome effect on his emotions and his ideals.

One could turn to almost any subject matter and see ways in which it has impact on man's basic patterns of thinking and on his emotions.

Children frequently respond with fine feeling in a discussion in science. It may be in response to profound ideas of such great patterns of the universe as time, space, change, adaptation, interrelationships, variety, and balance. It may be indicated in facial expressions. Children in stating hypotheses of their own are sometimes quite exultant. They also enjoy testing their hypotheses.

There is a constructive emotion which might be expressed in "a feeling of adequacy to operate a toy, an appliance or a situation." Sometimes this emotion is tied up in a feeling of belongingness in a cooperative enterprise with one's classmates. There may be a feeling of fear of certain types of things. Some children pass through a period of fear of very loud noises, such as train whistles although they themselves may be quite a source of noise. There is the emotion of anger when something breaks or bursts as in Jonathan's case or when something doesn't work. There may be the feeling of inadequacy when a child finds himself inferior in manipulation as compared with other children. There may be the fear of animals, fear of machinery, or of a storm. Teachers and parents need to be aware of the kind of emotions that are found in children in learning situations.

It may be that to some extent, one reason there are emotional aspects to some learnings in science is that there may be a physiological meaning of the learning to the learner. A study of abstractions indicates that these abstractions of children grow out of experiences with their own bodies. For instance, gravity, balance, equilibrium, speed, inertia, and heat may have definite meanings in terms of experiences in the past. We might say these ideas are based on memories of bodily impressions. As a result science learning uniquely involves both the body and the

mind as an integrated unit. It is only natural under such associations and integrations that there should be an emotional aspect to science education.

There are many ways in which science is related to emotions. There are feelings of appreciation of what one finds to be profound or beautiful in the universe. There are the emotions that grow out of the discoveries of science and inventions. These emotions may be positive and constructive, filling one with feelings of poise, stability and optimism growing out of the findings of science, but at times, there may be negative and destructive emotions, in that the progress in science has unleashed energies with which man may not be able to cope. There are the emotions in the face of uncertainty that may be quite negative. A task of the school at this time is to help children to face uncertainty with intelligent resourcefulness.

We see from this that emotions are of necessity a part of the reactions to life. There is a need of recognizing the constructive role they can play in the education of children in science in a democracy. The role of emotions in the development of behavior patterns is an important one.

CHILDREN RECONSTRUCT THEIR IDEAS OF THEIR PHYSICAL ENVIRONMENT

Children by the very nature of the case must revise their ideas as they have new experiences. They do reconstruct their ideas of the universe even as they go on to meet new experiences. In a sense their behavior corresponds to an industry or a home in which the normal activities are continued even as the building including the foundation, is being rebuilt. There are many instances in which children reconstruct for themselves in a short span, even minutes, what seems to be very fundamental ideas of the world about them. They continue on to new experiences even though the old foundation of their understanding is abandoned and a new one proposed. A study of children's ideas reveals children in a wholesome learning situation

or in the continued process of reconstruction of their ideas. They abandon and reconstruct their ideas of the environment more readily than the average adult.

This ability of children to reconstruct their ideas is an important ability to preserve in education. The progress made by the human race would never have resulted without this ability. The last three generations have been forced, frequently by necessity, to change their ideas as a result of new discoveries and inventions. A generation is needed which is educated to expect change and to direct the change to the welfare of all.

By the very nature of the case children make much more profound changes in their interpretations than adults do. In fact a young child may make changes in basic ideas almost continuously. A child may accept fairies one week and begin to abandon them as possibilities the next week. In a sense there is an evidence of almost inverse ratio in that the younger the child the more basic the interpretations that are involved because the young child is building the framework of his ideas of the nature of the universe. Hypotheses may begin in the element of anticipation or expectation of small children in their early experiences.

Concept Development in Children Is a Dynamic Process. Frequently adults disparage children's recollections of past events because the concepts of time expressed by the children do not conform to the adult's standard of time. They point to the confusion young children have with ideas of yesterday, today, and tomorrow, and their difficulty in realizing there is a year between Christmases and birthdays. Looking at the learning about the extents of time and all of the profound ideas of science from a developmental point of view will help adults to understand that the ideas of time require development and will provide the adult with a better appreciation of children's memories. A sympathetic adult can stimulate the growth greatly by beginning with a child's concept of time and helping the child to enlarge it thus provid-

ing the child with a better perspective for his own memories.

Time is a large element in learning and the concept of time is never fully mastered by any individual in an entire lifetime. Adults must provide children with opportunities to gain improved concepts of time.

Jean, a three-year-old, on an all-day travel to visit her grandparents, began at the end of a half hour to ask, "When will we get to Grandma's?" This question continued all day at intervals. Towards late afternoon, the comment was "My! won't we ever get to Grandma's?" This comment was made with considerable feeling.

One can look at Jean's experience with impatience and say, Jean had little concept of time or distance. This explanation of Jean is not one based on a dynamic view of the children, or of the universe. It is a negative approach.

A better interpretation is the positive dynamic one. Jean was having learning experiences. She was making associations of time with distance. She was learning about the extent of time, the length of day. She still had more to learn about time and always will have. Jean's learnings, as is true of much learning about time in science, was accompanied by the development of emotion.

Children Have a Sense of Humor. Frequently children's proposals have a fine quality of humor. The moments in teaching can be very rich when there has been a fine flow of laughter through the classroom when both children and teacher have joined in the fun. Such a thing occurred in a discussion in a rural classroom in North Carolina in which there were children of much farm experience. An attempt had been made to draw some meanings about the word "animals." Upon questions being raised about mules, a thirteen-year-old, rather large for his age, spoke in a whimsical voice and a smile on his face, "Mules—why, mules are mules," and the class, children from the farm with experience with mules, rocked with wonderful laughter that was refreshing to adult and children alike.

To a farm boy who thought there was no need of looking for a classification for a mule, it was not a refusal to learn but a fine bit of humor only appreciated by those who know mules. There is no better tonic for good relationships in the classroom than a good laugh (but never to humiliate an individual) in which the teacher participates.

Humor can be a part of science instruction. It can grow out of the science instruction and lead back into it. Interpretations about the universe will frequently appear to children as humorous. Douglas, eleven years old, at the close of a group discussion asked the instructor very seriously, "Are we animals?" The instructor gave an affirmative answer, whereupon Douglas went chuckling out of the room. He accepted the fact, but he found it humorous.

ADULTS AFFECT CHILDREN'S INTERPRETATIONS

Dave Cheney called across a street to an eight year old, "Hey, boy, do you want a cat?" The eight year old sprinted across gleefully, only to have a spitting, scratching kitten thrust into his hands. This kitten was not like any the eight year old had experienced. It was a frightened kitten, snatched cruelly from the mother cat as a result of Dave's disgust at being bothered by a litter of kittens on his premises.

There was no fear of the kitten on the part of the child in spite of the scratches. He held the kitten firmly but with a feeling of kindness, although this fighting bit of living furry mass was anything but pleasant. The eight year old, quite care-free a few minutes ago found himself suddenly responsible for a helpless but frightened bit of animal life.

He began to plan for this kitten as he trudged home. He dreamed about gentling this little "kitty" so it might become a dignified old cat like some of the cats he knew in the village. But his dreams were soon shattered as he reached home. The adults manifested fear and alarm at the sight of the defensive little kitten and questioned

the child's intelligence at being such an easy mark for old Dave's cunning. The behavior of the adults changed his attitude from benevolence to that of fear. The change was so great that the emotions of disappointment and grief for the loss of his dream affected his appetite for several days.

Adults very frequently fail to consider the effect of their behavior upon children. Adults, too, can be blind to the ideals and dreams of children. How many times adults enter and trample down the altars of the inner shrines of children!

Five-year-old James, playing in the yard, was attracted by the movements of a garter snake. It was his first encounter with a reptile. Fascinated by this creature which gracefully glided out of his way, he had no feeling of fear. He ran into the house to tell of his discovery. He knew no name for the animal, so he got down on the floor and imitated the snake. The older members of the family indicated their concern and ran into the yard to kill the snake. The child, observing the adults, changed his attitude from curiosity to fear and the new attitude toward snakes was so strongly enforced that it remained into adulthood.

We encounter another illustration of the feelings engendered between racial or religious groups. Small children of different groups will play together with little or no sense of discrimination until some adult introduces his prejudices. The new attitude may become fixed and intolerant and a strong influence on the emotions and the quality of citizenship.

A six year old white girl was visiting with her parents at a home on an Indian reservation in Arizona. She was playing with a group of Indian children and was overheard to suggest "Now, let's play Indian, shall we?" "Playing Indian" was a game. She saw no relation between these Indian children and the game.

Sometimes explanations given by adults are mixtures of fact, superstition, and misinformation. For the child, the result is unwholesome attitudes and maladjustments.

It is not so much the lack of information that is to be regretted as it is the maladjustment that comes about because the individual does not know what is reliable information nor how and where it is to be secured.

In one family the mother was very much frightened by electrical storms. At such times she would gather the children about her in a dark closet deep in the interior of the house. One of the daughters since grown to adulthood tells of her great desire now to get outside during an electrical storm. Sometimes adult's behavior reverses itself in the behavior of the children when they are free to choose for themselves.

STUDYING CHILDREN WHILE TEACHING SCIENCE

What Kind of Boys and Girls Are We Developing? Teachers will find their teaching enriched if they will study children as they teach. Science with its challenging content and its rich contribution to the attitudes and behavior of both adults and children offers unique opportunities for the study of children.

The greatest concern in studying children is not how much information children have secured, important as that may be. Rather, the main emphasis should be on what kind of boys and girls we have. What kind of thinking do they do? What are their outlooks upon the world? Are these outlooks constructive and democratic? Do the children think for themselves? Are they developing good ways of thinking? Are they learning to be resourceful? Are they developing responsibility?

At all times teachers should be alert to the kind of behavior changes that children are making. The teacher may ask: "Are the children developing dogmatic attitudes, or are they willing to consider new ideas? Are they tending to accept every idea they hear without hesitation? Do they look for further evidence before drawing conclusions? Are they learning to use authentic books? Do they report on out-of-school

experiences in a wholesome way? Do they propose explanations? Are they learning to plan? Will they work with others? Do they have constructive outlooks? Are they realistic? Are they resourceful and responsible?"

In this kind of study it must be recognized that behavior may reflect the home and the general background of the children. A dogmatic parent may cause a child to be gullible.

Studying Spontaneous Behavior. It should be kept in mind that it is the behavior in which a child has had some degree of freedom of choice which is the most useful for evaluation. The closely worded or directed question of the quiz program and the rigid recitation have little significance in evaluating behavior. In a sense it is the spontaneous behavior of children—the proposal of something to do, the inquiry, of choice of language in indicating open-mindedness, the critical-mindedness, poise, resourcefulness, the challenge of a statement, the willingness to consider new ideas and to take on new duties, the use of old learning in new situations and learning which is useful in evaluation. All of this seems to favor a type of discussion in science instruction which allows for freedom of expression and thinking.

A comment, reply, question or other proposal of children can have qualities of spontaneity and come out of instruction, particularly if it is developmental. Anything a child or adult does in which there has been a degree of freedom of choice, is to that extent spontaneous. We have frequently used the word "proposal" as a term to indicate any comment from children, whether it be a fact, a question, a problem, a bit of content, a tale of the imagination, an hypothesis and so on. The proposal as we describe it is something which comes out of the intelligence of the child and serves to a degree to reveal where he is in his thinking.

Developmental procedures in elementary science leave a large opportunity for spon-

taneity. But the question-answer procedure of the traditional recitation which called for a definite wording to be correct left little choice and not much opportunity for spontaneity.

It is recognized in this that teachers need to study children as individuals and as groups and from a total, rounded-out point of view of education. The contention here is that science with its profound meanings offers unique potentialities in studying children from this developmental point of view. Children should not be evaluated as if the development in behavior relating to science were isolated from all other aspects of their lives. Science, as the interpretation of the environment, should be thought of as an intrinsic part of the life of children in the modern world, a part that may be an important factor in building desirable behavior.

Are the Children Developing Responsibility and Resourcefulness? The human being, whether young or old, is an exquisite and complex being which has in it possibilities for a great variety of behavior. The human being can rise to heights of great service to others and at other times be a demon, snapping at anyone who would dare to speak to him. Perhaps nowhere is the pattern "variety" better exhibited than within a single human being. A child may be happy and loveable, tearful and sad, or pugnacious and intolerant, depending upon the forces inside and outside him. There are so many forces within and without, inherited and environmental, which can play on children and to which they can react that the human organism is never exactly the same from minute to minute.

A child is learning to operate with these forces in these early years. He can be conquered by those forces and become defeated, a timid soul for his entire life or he can learn to operate himself with these forces so that he becomes a resourceful and responsible individual in a democracy. The understanding parent or teacher can do so much toward determining the direction of

his behavior patterns. Many of his behavior patterns grow out of his experiences with the materials of the environment. The meanings he accepts from these experiences have much to do with the kind of individual he becomes. He may move through those experiences with the materials about him and tend to develop irresponsibility which we might term negative patterns or he may tend toward resourcefulness and responsibility which we might term positive patterns.

Studying How Children Interact with the Physical Universe. In the early months of a child's life, definite patterns of behavior begin to emerge in regards to the materials found about him. These patterns grow out of interpretations a young child develops for himself through first hand experience with the materials and what he accepts from all that the adults tell him. Emotions are quite likely to be developed along with these interpretations.

We need to study children in reference to the way they work with materials. Do they tear the materials apart? Do they examine a toy with care? Are they afraid of the toy? Do they exhibit behavior in keeping with safety or do they rush in to grab materials without thought? Do they push their hands about impulsively or do they think through their behavior with poise? Do they seem unnecessarily afraid? Do they assume responsibility for their actions? Do they exhibit care for a toy? Where do they leave it, on the floor for others to kick about or fall over or in a place where it will not be destroyed? Are they curious about the source of energy of the toy? Do they succeed in operating the toy? Do they use their imaginations as they play with the toy?

Of course all of these appraisals of children's behavior must be made in terms of the child's growth and development, which is best determined through children's present and past experiences.

A child tends naturally as an active organism to utilize the materials about him.

He may use them for different purposes than those for which the materials were designed. He may use a delicate toy as a hammer or as a teething ring. Sometimes a child seems ruthless and destructive because he has toys placed in his path which have purposes for which he has little understanding.

A child's attempt to pull things apart is not necessarily associated with any bad motives. A child is a learning organism. His learning to a very large degree is learning about objects, animate and inanimate. That things can be pulled apart and rendered useless is something to be learned. Likewise, that something dropped may be broken and damaged. How else is a child to learn it except through observation and experience?

Overly Cautious Behavior. Donald, five years old, had his first experience with a balloon. While blowing air into the balloon, it burst. The adults about him enjoyed the situation because Donald was greatly puzzled by the phenomenon. However, in Donald's question, "Where is it?" was locked a lot of emotion. How could any thing as big as that balloon seemed to be when filled with air, become annihilated to but a fragment of rubber. In many ways it was a big learning for a boy of five. It took him some time to adjust fully to the situation.

For a while Donald was overly cautious with all materials as a result of this experience. Here was something easily destroyed. He became fearful that other of his toys would be easily destroyed. Had the adults treated it more as a thing to be expected, Donald would have developed a less cautious attitude towards all materials. Donald needed to learn such ideas as: some things are easily destroyed but some other things wear out slowly and are not easily destroyed.

Impulsive Behavior. Like most behavior patterns, the ideal behavior is a balance between extremes. No one wants Donald to grow up in life overly cautious. Yet one

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does not want Donald to develop reckless behavior.

Marie, nine years old, was irresponsible and careless with materials. In observing Marie at school and at home, one could not but be concerned about her own safety as well as that of her friends. The most innocent looking object seemed to become a lethal weapon as soon as it became a part of Marie's immediate environment.

In a classroom of ten year olds, a duck was given the freedom of the room. Walter, a ten year old, impulsively placed the duck on his shoulder. Of course the duck with no equipment for resting on the child's shoulder fell off and as he hobbled off he left pools of blood across the floor. The observer had reason to believe that in this particular behavior, there were no sadistic tendencies. After studying the boy, it was apparent that he had not been taught at home or at school to think through his behavior in terms of considering the consequences of events. But allowing this child to continue these impulsive behavior patterns may result in sadistic trends.

The meanings involved, that is, the subject matter, of a situation may be of great assistance in developing a more thoughtful behavior on the part of Walter, for instance, examination of the duck's feet. Are they adapted to Walter's shoulder? Can the duck hold on? Can he fly enough to prevent a hard fall? To what kinds of places

are duck's feet adapted? Also along through this development there should be a consideration of values of purposes. Do we want the duck to be hurt? Do we want other living things needlessly to suffer? Are we responsible for the duck in our classroom? There should be a lifting of children's values (and frequently a teacher's values) through a give and take discussion.

Resourceful and Responsible Behavior Needed in a Democracy. Neither the overly cautious behavior of Donald nor the impulsive behavior of Marie and Walter is to be desired. In a democracy we need resourcefulness and responsibility. Intelligent resourcefulness and responsibility may flow out of thinking through to possible consequences of behavior. This involves consideration of safety of others as well as oneself. To run with an opened knife or scissors is to invite disaster. To throw burning matches about is to invite fire. Resourcefulness should never be confused with mere impulsiveness. Intelligent resourcefulness is a great goal for all democratic peoples.

But intelligent resourcefulness and responsibility must be learned. The human organism at birth with its dynamic drives has the capacity for this learning. The parent and the teacher must make certain that children use these great dynamic drives in such a way as to develop intelligent and democratic behavior patterns.

GERALD SPELLMAN CRAIG

PROFESSOR GERALD SPELLMAN CRAIG, noted science educator, was born in De Graff, Ohio, May 6, 1893. He later moved to Texas. He received a B.S. degree from Baylor University, Waco, Texas, in 1915. He completed an M.A. degree at Teachers College, Columbia University in 1917. He attended the University of Pennsylvania 1919-21. His Ph.D. degree was given by Teachers College, Columbia University, in 1927.

Dr. Craig's teaching experience includes: Head of the Science Department, Ballinger, Texas, High School, 1915-16. He also taught high school science in Pennsylvania, in New Jersey, and at White Plains, New York, 1924-25. During the summer of 1916 he taught physics at Baylor University. He taught physics and chemistry at the Pennsylvania State Normal School, Bloomsburg, Pennsylvania, 1921-23. Summer session teaching has included Pennsylvania State College, 1923 and 1924 and in a number of other colleges more recently. He became instructor in elementary science at the Horace Mann School, Teachers College, Columbia University in 1925. He served as consultant in elementary science 1924-27, and as associate in elementary science at Horace Mann School and Teachers College, 1927-29. He became Assistant Professor at Teachers College in 1929, and at the same time maintained an active teaching relationship with Horace Mann School. In 1941 he was made Professor of Natural Sciences in Teachers College, a position and title he presently holds.

It was during the period 1924-27 that Dr. Craig made investigations which led to the development of a program for science in the elementary school. His doctoral thesis *Certain Techniques Used in Developing A Course of Study for the Horace Mann School* was a culmination of his activities during this period. This thesis and the associated work of Dr. Craig undoubtedly has been the greatest factor in the develop-

ment of the type of elementary science taught in present day American elementary schools. The present day philosophy and psychology of elementary school science largely stems from the oft-quoted and widely read doctoral thesis, *Thirty First Year-book*, and associated writings.

Dr. Craig's publications have been many, both as to articles in numerous magazines, as well as to elementary science textbooks, elementary science teaching methods, pamphlets and brochures relating to various aspects of elementary science, and contributions to Yearbooks and encyclopedias. Following his thesis, his first major publication was the *Horace Mann Course of Study in Elementary Science* (1927). Next came contributions to the primary and intermediate science sections of *The Classroom Teacher* (1927). *Science for the Elementary School Teacher*, first published in 1940, was revised in 1947, and at the date of this writing is now in process of a second revision. His *Science In Childhood Education* published in 1944 has been equally popular. His first elementary science textbook series *Pathways in Science* (of which and the following series Dr. Craig has been senior author) published in 1932, may accurately be described as the first modern day elementary science textbooks. This series set the standards and patterns for the various elementary science textbook series that have been written since that date. The *Our World of Science* series was published in 1946, and the elementary science textbook series *Science Today and Tomorrow* followed in 1954-56. The Craig Elementary Science series have been the most widely and extensively used of any elementary science series published. Thus they have exerted a very great influence upon the kind of science taught in American as well as in many foreign elementary schools. The books have appeared in Canadian editions as well as in German, Thai, and Japanese translations. Presently

Dr. Craig is engaged in revising *Science for the Elementary School Teacher* and in preparing a brochure *Teaching Elementary Science* for the Department of Classroom Teachers and the American Education Research Association of the N. E. A. series *What Research Says to the Teacher*. Dr. Craig made notable contributions to the National Society for the Study of Education Yearbooks of 1932, 1947, and 1937, as well as the Department of Elementary School Principals (N. E. A.) Yearbook, 1953. Dr. Craig was a member of the Committees for the Thirty-first and Forty-sixth Yearbooks of the N.S.S.E. A complete list of Dr. Craig's published articles are not available but in number and distribution they are most extensive.

Dr. Craig is a veteran of World War I, having served as 1st Sergeant in the A.E.F. in France in 1917-19.

Dr. Craig married Prudence Bower December 27, 1915. Their son Lawrence C. Craig has a Ph.D. degree from Columbia University and for many years has served as Geologist in the Minerals Deposit Branch of the U. S. Geological Survey. He and Mrs. Craig with their son and two daughters live at Grand Junction, Colorado. A daughter Alice Estelle (Mrs. Richard A. Erney) lives in Cedarhurst, New York while Mr. Erney is completing his Ph.D. in American History at Teachers College.

Dr. Craig has served on numerous committees such as the New York State Elementary Science Committee 1926-31; Secretary of the Conference on Education of Teachers in Science 1936-1940; President of Science Education, Inc. 1931-43; and numerous committees of the National Council for Elementary Science and National Association for Research in Science Teaching.

Membership in organizations include: National Council for Elementary Science, National Association for Research in Science Teaching, New York Academy of Science, Phi Delta Kappa, Kappa Delta Pi, Association for Childhood Education Inter-

national, A.S.C.D., American Association for the Advancement of Science (Fellow 1929), John Dewey Society (Fellow), American Education Research Association, National Science Teachers Association, and the Central Association of Science and Mathematics Teachers. Dr. Craig is listed in *American Men of Science*, *Leaders in Education*, and *Who's Who in America*. Dr. Craig served as President of the National Council of Supervisors of Elementary Science (1930-31), and as President of the National Association for Research in Science Teaching (1936).

Dr. Craig has been interested in all aspects of elementary school science, in developing professionalized content for elementary school teachers, in evaluation of the behavior of children in terms of purposes of science education, and in an ecological study of children. He has served as elementary science consultant to many public school systems—city, rural, and state. He has served as director of natural science field studies (Arizona, Alabama, Puerto Rico, New Hampshire, New York, and so on). He studied the status of science in elementary schools in Europe in 1931 and in Puerto Rico in 1948.

During the last thirty years or so Dr. Craig has been one of the most active members of the National Council for Elementary Science, rarely missing an annual meeting. Probably no other person has as good a record of attendance or shown a greater degree of interest in promoting its professional development. This attitude and interest probably characterizes as well as any one thing the abiding interest and faith of Dr. Craig in the importance of a dynamic, functional program of elementary science in American public schools. Unfortunately too few American science education leaders have displayed a similar professional attitude. Dr. Craig truly *lives* elementary science as well as *teaching, writing* and *consulting* elementary science. The results speak for themselves and Dr. Craig is more responsible for the noted

progress of elementary science since the old Nature Study days than any one else. His devotion to a cause and his faithfulness to an ideal, has never wavered. This does not mean at all that his views are the same as those he held in 1926-27—they have progressively developed with the changing times. His has been a dynamic leadership.

Dr. Craig will always maintain an active interest in elementary science. Retirement will never be a period of inactivity for him. Although he has applied for retirement from Teachers College this June 30, Dr. Craig has planned a ten-year program of research and writing that will more than keep him busy. He plans a ten-year research program on *An Ecological Study of Children* which will take him into classrooms in all parts of the country, working with children, teachers, and parents. This is, in a way, a return to the elementary classroom—an activity practiced and so loved by Dr. Craig for many years. He is very enthusiastic about this program and believes it is of very great importance. He will serve as consultant to many public and state school systems, having some such consultations scheduled as far in the future as 1958. Along with this field work, Dr. Craig will be writing professional materials based upon a dynamic psychology of children. He will retain headquarters in New York City and maintain a home residence at 460 Riverside Drive. Seemingly Dr. Craig will be as

active in this field research study as he has ever been in his life. Significant and important as have been his contributions in the past, it is most pleasing to know that his future contributions in field work and writings will be equally so.

The writer has known Gerald and Mrs. Craig ever since he went to Teachers College in 1926 where Gerald was then completing his doctoral work. We were fellow students in one or two classes. Later Gerald was a beloved teacher and still later an associate on the Board of Science Education, Inc. During all of these years, Gerald has been a true, steadfast friend whose words of encouragement, often given when needed most, have meant so much to the writer.

Gerald Spellman Craig is recognized everywhere, here in the United States as well as in many countries abroad, as the greatest leader that Elementary Science has had. This leadership carries along with it an obligation of responsibility and professional advancement that has been most adequately met by Dr. Craig. Someone has said that when you see a great man you can see the influence of a great woman. To Mrs. Craig must go a great deal of the credit for the success attained by Dr. Craig.

So to Gerald Spellman Craig deservedly goes this first Science Education Recognition Award.

CLARENCE M. PRUITT

ELEMENTARY SCIENCE IN NEW YORK CITY *

HARRY MILGROM

Supervisor of Elementary Science, New York City Public Schools, New York, New York

IN July of 1954, the Board of Education of the City of New York adopted, for the first time, a "Course of Study in Science for the Elementary Schools, Grades K-6." This action completed the process of organizing a science sequence from the first year

of Kindergarten to the senior year of High School.

The next step was taken with the launching of a three year "Elementary Science Project" to develop implementation materials for our new course of study.

We should like this project to provide our children (570,000) with science experiences and activities which will help:

* Presented at meeting of the National Association for Research in Science Teaching, Teachers College, Columbia University, April 18, 1955.

- a. Keep alive and direct, in ever-widening circles, their natural urge to explore and interpret their environment.
- b. Bring to full bloom the buds of ingenuity and creativity with which they are endowed.
- c. Equip them with the necessary attitudes, concepts, knowledge, and skills to make their lives as individuals and as members of society, meaningful and worthwhile.

We should like this project to provide our teachers (21,000) with functional materials for a structured, yet flexible, program of science instruction.

We should like this project to serve as the instrument for weaving the stout threads of science awareness and understanding into the fabric of the elementary school curriculum.

The "Elementary Science Project" is organized along the following lines to expedite the production of materials:

- a. The course of study content is divided into seven major themes that appear in all the grades—Plants and Animals, Weather, Communication, Transportation, Electricity, The Earth and Its Resources, and The Earth in Space.
- b. For each of the seven themes, a science area committee is set up. Each group consists of: representatives from pilot schools, district science chairmen, curriculum assistants, and a science consultant. Each group is re-

sponsible for a K-6 implementation of its particular area of the course of study.

- c. Thirty-one schools, serving as pilot schools, form the backbone of the Project. In each pilot school, supervisors, teachers and children cooperate in the development and evaluation of science experiences and materials for one of the seven areas. The school representative reports all findings to the appropriate area committee.
- d. A central coordinating committee is responsible for collating and editing the work of the seven committees for final publication as a teachers handbook in elementary science.

The Elementary Science Project is a joint undertaking of the Division of Elementary Schools and the Division of Curriculum Development. Needless to say, the full resources of the various bureaus (Audio-Visual, Broadcasting, Curriculum Research, Educational Research, Library and Science) of the Board of Education are available to the Project committees. In addition, we are assured of the whole-hearted cooperation of teacher training colleges, public libraries, botanical gardens, museums, zoos, science teachers, parents, and industrial organizations in this major effort to develop a first class science program for the elementary schools of New York City.

DON'T DISCARD THOSE 3D GLASSES *

HARRY MILGROM

Supervisor of Elementary Science, New York City Public Schools, New York, New York

MANY of us, these days, are asking questions about three dimensional movies. What strange mechanism makes possible the illusion of depth? What role do the glasses play in shaping the flat images on the screen into startlingly realistic figures?

Let's find the answers.

The first phase of this problem has to do with vision. Your two eyes are sepa-

* Paper originally written when 3-D motion pictures were in vogue. If these glasses are not now available, polarizing sunglass lenses may be used. The theory of polarized light experiments remain unchanged.

rated from each other by some 3 inches. When you look upon a scene, each eye sees it from a slightly different angle of view. Your brain then mixes the two messages which it receives, to form a three dimensional picture.

Try this. Thumb your nose with your right hand. Close your right eye—you see the palm. Close your left eye—you see the back of the hand. If the two views are as different as just indicated, the fused picture places the object as being very close (actually too close for comfort in this case). If the two views are not much

different, the fused picture places the object as being farther removed. It is in this way then, that the two eyes and the brain distinguish the varying depths in a three dimensional scene. One eye, alone, cannot sense depth accurately. Try this. Let one person hold the cap of a fountain pen in his outstretched right hand. Let a second person, with one eye closed and holding the body of the pen in his outstretched right hand, approach the first one and try to insert the pen into the cap. A simple job for two eyes, becomes a difficult task when only one eye is used.

The second phase of this problem has to do with polarized light. In ordinary light, the vibrations that stimulate the eyes to see, occur in all directions at right angles to the incoming ray of light as shown in Fig. 1.



FIG. 1

Try this. Fasten one end of a long rope to a fixed point. Swing the other end around like a jump rope.



FIG. 2

This resembles the vibrations in Fig. 1. Ordinary light becomes *polarized*, when all the vibrations, except those in one direction, are squelched.

Try this. Pass the rope between two yardsticks (or other long sticks), separated by the rope thickness, as shown in Fig. 3.

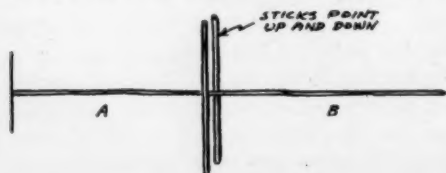


FIG. 3

A round and round motion of the rope on side B gets past the sticks, to side A, only as an up and down vibration. In other words, on side A the movement of the rope is *polarized vertically*. Now hold the sticks sideways as shown in Fig. 4.



FIG. 4

A round and round motion of the rope on side B gets past the sticks, to side A, only as a left and right vibration. On side A the movement of the rope is *polarized horizontally*. Finally, arrange two sets of sticks as in Fig. 5.

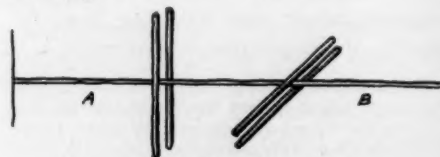


FIG. 5

Now very little vibration of the rope on side B can get through to side A, since vertical movements are stopped by the horizontal set and vice versa. You have succeeded in suppressing most of the vibrations.

The transparent plastic, used as "lenses," in the glasses supplied to viewers of three dimensional movies, can *polarize light waves*. Innumerable crystals, facing in the same direction, are imbedded in the plastic material.

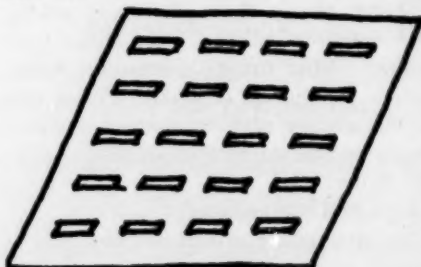


FIG. 6

These microscopic crystals act like slits to polarize light, in the same manner the sticks polarized the vibrations of the rope.

A three dimension movie is shot with two sets of lenses separated by eye distance. Fig. 7.



FIG. 7

Each lens views the same scene from a different angle (like your two eyes) and two sequences are produced (Fig. 8).



FIG. 8

From the booth in the movie house, these two sequences are projected on the screen at the same time. The next time you see a 3D picture, look back to notice the two separate beams that come out of the projection booth. The left projector, however, sends its light through a horizontal polarizer, while the right projector sends its light through a vertical polarizer (Fig. 9).

These two polarized images overlap but do not coincide when they fall on the screen.

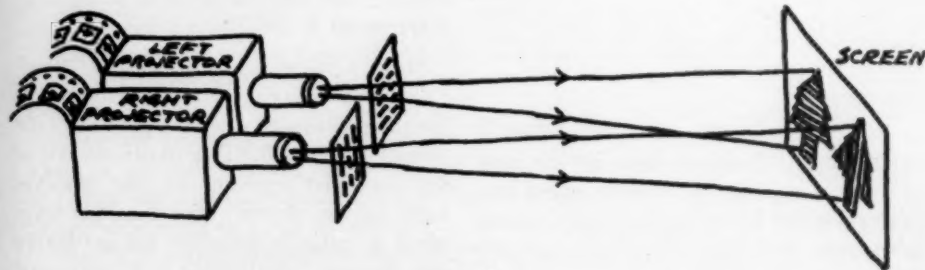


FIG. 9

Try this. Remove the special glasses, while viewing a 3D movie, and notice how blurred the scene becomes because you see two of everything. Light from both images enters both eyes.

Fig. 10 shows how the glasses separate the images.

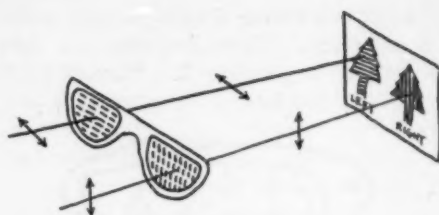


FIG. 10

The left "lens" permits only the horizontally polarized light from the left image to enter the left eye. It excludes the vertical vibrations. The right "lens" permits only the vertically polarized light from the right image to enter the right eye. It excludes the horizontal vibrations. The eyes then receive the same slightly different views they would receive, if they looked upon the original set on the movie lot. By the magic of polarized light, the scene is sculptured into three dimensions.

Many fascinating experiments on the nature of polarized light can be performed with the aid of these goggles. Don't throw them away!

Experiment 1

Remove the ear wires from a pair of glasses. Separate the left "lens" from the

right "lens" by cutting the bridge. (Fig 11.)



FIG. 11

Look at a source of light through A and B separately. Each side dims the light slightly as it polarizes it. Place B on A (Fig. 12) and look at the same light.

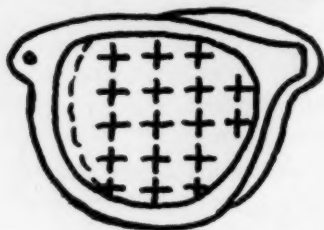


FIG. 12

The light is almost extinguished except for a purple glow. Using A and B in this way, blocks light in the same way as the crossed sticks in Fig. 5 stopped the movement of the turning rope. However, if B is placed on A at right angles, then horizontal vibrations of light can move through both "lenses" and the light remains bright. (Fig. 13.)



FIG. 13

As B is rotated back from this position to the first one, the light becomes dimmer.

Experiment 2

Place a pair of 3D glasses on a piece of white paper. Look at them as you turn a single "lens," slowly, in front of one eye. The right and left sides of the glasses, will alternately blink black and white. Can you explain this?

Experiment 3

Light is often polarized when it is reflected from a surface. Test reflections from waxed furniture, floors, streets illuminated by lamp light, dishes, vases, walls, mirrors and other objects, by passing the light coming from them, through a single "lens,"

rotated slowly in front of one eye. How can you tell when the light is polarized?

Experiment 4

The sky appears blue because tiny particles in the atmosphere reflect the blue portion of sunlight in all directions. Examine different parts of the sky, as in experiment 3, to determine the amount of polarization.

Experiment 5

The moon shines by reflected light. Investigate, as in experiment 3, the degree of polarization for the different phases and positions of the moon.

Experiment 6

Fold a piece of scotch tape into a complicated pattern with varying thicknesses of tape in different places or crumple a piece of cellophane into a small wad. Place this between the crossed "lenses" of Fig. 12 and view against a bright light. Notice the magnificent color changes that occur as B is rotated. These colors are closely related to the beautiful colors of butterfly wings and oil slicks. Examine other transparent materials (like plastic food bags) for this effect.

Experiment 7

Shine a bright light through one "lens." Examine it as in experiment 3. Notice how the glare is reduced when the position of the "lenses" is crossed. This illustrates one of the suggested remedies for the glare of night driving. An oncoming headlight beam which is vertically polarized will not bother you, if your windshield is a horizontal polarizer.

Note 1. In the interest of simplicity, this 3D story was told in terms of horizontal and vertical polarizations. In actual practice, because of technical advantages, the polarizations are turned through an angle of 45 degrees so as to produce the vibrations shown in Fig. 14,



FIG. 14

and the crystal slits in the 3D glasses are arranged as in Fig. 15.



FIG. 15

Note 2. The 3D comic is based upon the

same general principles but does not make use of polarized light.

Instead the right eye view is printed in red and nearby, the left eye view is printed in blue-green. This produces a confused picture when it is observed by the unaided eyes. But, when the 3D comic goggles are worn, this is what happens:

1. The right eye, looks through a blue-green cellophane "lens," which causes the red print to appear black. The blue-green portion gets lost as it blends into a blue-green background. In this way the right eye sees only the right view of the scene.
2. The left eye, looks through a red cellophane "lens," which causes the blue-green print to appear black. Now the red print disappears in a red background and the left eye sees only the left view of the scene.

The brain then blends the right and left eye images, giving rise again, in this manner, to the startling illusion of depth.

ON WHAT BASES SHOULD SCIENCE LEARNING MATERIALS BE SELECTED ON THE ELEMENTARY LEVEL? *

HARRY MILGROM

Supervisor of Elementary Science, New York City Public Schools, New York, New York

AN interesting cartoon which appeared recently in a New York newspaper, shows a visitor at the bedside of a hospital patient saying, "The office collection wasn't enough to send flowers, but here's a package of seeds!"

We who work at the elementary level are pretty much in the same position as this hospital visitor. We should like to feel that we are bringing to the children the seeds of scientific interest, understanding, and knowledge, which may some day, with proper care, come to a full flowering.

The 1952 enrollment figures show that out of a total school population of 32,000,000 students,

23,000,000 or 71% attended elementary schools,
7,000,000 or 22% attended high schools, and
2,000,000 or 7% attended colleges.

(1955 *World Almanac*)

From this it seems clear that the seeds

must be planted in the elementary grades, if we are to have an informed American people, capable of keeping pace with the rising tempo of scientific progress.

Adults as well as children are eager to learn about and make use of new scientific developments. This genuine interest is often diverted by pseudo-scientific influences. Does your toothpaste contain ZP-235? Have you had your fill of chlorophyll today? This, for example, (a strip of half-silvered plastic material worn over the eyes) in case you do not recognize what any child could identify, is a pair of "ultronic-transvideo" goggles.

Science learning materials on the elementary level should make the pursuit of science by young people just as intriguing as and even more rewarding than the pursuit of their favorite comic book, television or radio program.

Learning materials selected for elementary science should:

* Presented at meeting of the National Association for Research in Science Teaching, Teachers College, Columbia University, April 18, 1955.

1. Be real things, whenever possible, rather than representations of real things.
2. Be readily available in school, at home or in the community.
3. Be easy for children and teachers to assemble and use.
4. Be safe for the youngsters to handle. In most situations, for example, plastic containers and tubing may be used in place of similar glass materials.
5. Be clearly visible to all concerned.
6. Help satisfy the natural urge of young people to probe and explore.
7. Help the pupils find answers to some of their questions about the world in which they live, through firsthand doing experiences.
8. Make the problem on hand more meaningful and be clearly related to it.
9. Help the children grow in their abilities to observe carefully, report their observations and make predictions based upon these observations.
10. Help the pupils develop initiative and resourcefulness in their approaches to problem solving.
11. Encourage the children to be bold in their use of new materials and techniques.
12. Simplify the complex, for better understanding of basic principles.
13. Be stimulating and challenging so that children will be eager to do more science work in school or at home.
14. Help develop the creative abilities of the youngsters through project planning and construction.
15. Enable the boys and girls to experience the thrill of making "discoveries."
16. Help the children grow in responsibility through experiences with cause and effect relationships. (If you neglect to water a plant it will die.)
17. Give the children the immense satisfaction of finding out that a tentative explanation is correct, or that a homemade device really works.
18. Help the youngsters learn to cope with new and unexpected situations. (How can North be found in a strange location?)
19. Help the youngsters become more secure through knowing. (What are shadows? Why do doors creak? What is lightning?)
20. Bring to the boys and girls an appreciation of the beauty and rhythm of natural phenomena. (The flower, the butterfly, the pulse of night and day.)
21. Help the children learn to work together in planning and carrying out science activities. (The class garden is a fine project.)
22. Inspire children to look forward to possible careers in science.

The potentialities of using science learning materials based upon these criteria may be illustrated by the two following experiences with air, water and simple toys.

THREE BAGS FULL

How can youngsters be shown that they are surrounded by an invisible, but real substance called air? Try this direct approach. Obtain a large plastic (polyethylene) food bag. When empty, it is flat and looks like this—



Fill the bag with wood blocks, marbles, sand, or any other solid material. It takes on this appearance



The children see that the material makes the bag bulge. They feel the content as it presses against the sides of the bag. Putting a real thing into the bag makes the bag puff out.

Pour water into the bag. Once again the bag swells up.



Ask the children to poke a finger into the water against the side of the bag. They feel the water push back on the finger. They see the water on the inside. Putting real water into the bag makes it bulge.

A Bag Full of Air

Open the bag and move the mouth first through the air.



When the bag bulges, close its mouth by gripping it tightly with one hand.



No substance is seen inside, yet the bag blows up. What's the explanation? The children feel the presence of something in the bag. What is it? It's a bag full of invisible air! Air makes the bag bulge. *Air is a real thing.* (Can a wish make the bag bulge?) *Air fills the space in the bag.* Wherever the bag is waved, in the room, on the street, in the basement, on the roof, or in the park, the bag fills up in the same way with invisible air. *Air is all around us.*

A Bag Full of Bounce and Wind

Fill the bag with air. Push down on the closed bag. It feels soft and springy.



That's why most automobile tires are filled with air. Place a heavy book on the closed bag. The invisible air in the bag supports the book. The bags (inner tubes) in four tires hold up the heavy weight of a car in the same way. What happens when the bag is opened? The book falls, pushes out the air, and flattens the bag. This is a flat tire! Fill the bag with air. Hold its mouth near the face of a child as the air is squeezed out. The child feels a wind.

Wind is moving air. The same wind turns a pinwheel or blows scraps of paper.

A Bag Full of Sound

Fill the bag with air. Insert a toy horn into the bag so that the mouthpiece is beyond the part closed by the hand.



Press the bag against the chest. The horn blows. Press again. The horn blows again and again until most of the air is squeezed out. This is a bagpipe! The children ask, "Is there a bag inside of us from which air is squeezed when we blow the horn?" The lungs are such bags. And muscles (diaphragm, chest muscles) push against the lungs to force the air inside of them out.

WATER, WATER EVERYWHERE

A drop of water can be used to fire the imaginations of children at every grade level and set them off on a lively, fruitful adventure.

At an appropriate time, when the children become aware of the need to learn more about water, they can, individually and as a group, explore many of its characteristics in the simple ways which I shall now describe.

Give each youngster a three inch square of wax paper with a few drops of water scattered upon it. Use a medicine dropper to distribute large and small drops.



Get the children started by suggesting that they:

1. Examine the wonderful shape of a drop of water. Will it take this shape on a piece of ordinary paper? Why not? How does the shape of a large drop compare with that of a small one? Why are they different?
2. Notice how a drop glistens like a moon-

stone. Will a drop of red ink look like a ruby? Green ink like an emerald? Black ink like a black onyx?

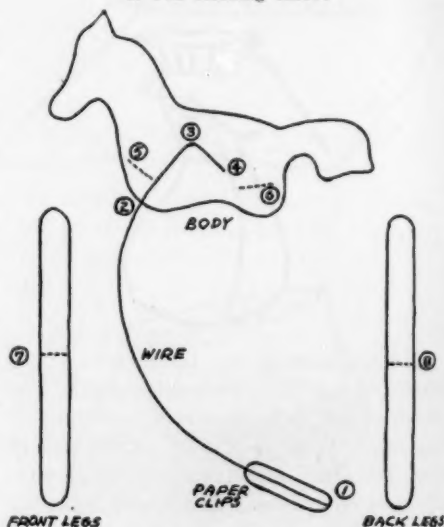
3. Push small drops together and watch them merge. Is this how drops of water in a cloud grow larger and larger, until they are heavy enough to fall as rain? Did this type of fusion play a role in bringing together the life elements in the mud of bygone ages?
4. Hold the wax paper vertically. Do the small drops roll down? Do the large drops roll down? How is this related to clouds and rainfall?
5. Touch a drop with the tip of a pencil. Does it seem to come alive as it wets and crawls up on the pencil? What other things does it wet?
6. Poke a drop with the pointed tip of a small birthday candle. Does the drop seem to have a "skin" that cannot be penetrated? Do water insects have a waxlike coating on their legs which keeps them from pushing through the water? Is that why they can walk on the surface of a pond? What other things doesn't the drop wet?
7. Place the tip of a pencil in contact with one part of a drop and then move the pencil. Does the drop stretch out and follow the pencil? Does the drop try to hold itself together?
8. Touch a colored drop with a piece of paper towel or blotter. Does the color spread rapidly up into the paper? Is this how water spreads in soil to reach the roots of plants? Is this why a blotter blots or a towel dries? Which would be a better material for a raincoat, the paper towel or the wax paper? Why?
9. Place a speck of soap or detergent powder on a drop. What happens to the drop? Does it wet the wax paper now? Is this why the combination of soap and water is better able to wet and remove grease from soiled hands than water alone?
10. Place the wax paper on a printed page. Look at the letters through the clear drops. Do the drops magnify the letters? Do the large drops magnify more or less than the small ones?
11. Touch the top of a drop with the tip of a fountain pen. Does it leave a speck of ink on the drop? How many separate specks can you place on the drop? Can you make a speck picture of a face on the drop?
12. Leave a colored drop of water on the wax paper overnight. What do you find the next day? What happened to the water? What happened to the color?

These are just a few of the findings of children and teachers as they use this "science equipment." Introduce your children to these little drops of water and share with them the thrill of discovery.

SIMPLE TOYS *

Here are the plans and directions for making three toys which I showed on the "Time for Science" television program. See how many science ideas you can discover as you have fun making and using these toys.

I. The Rocking Horse

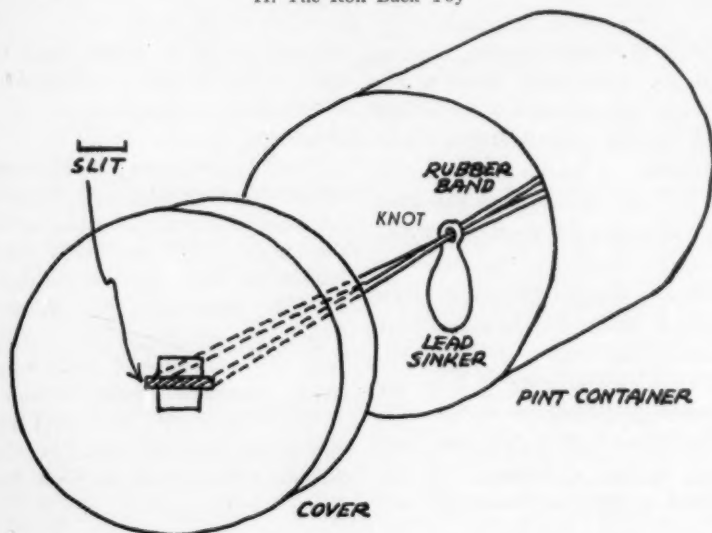


1. Use carbon paper to trace the body and legs of the horse on light cardboard.
2. Cut the body and legs out of the cardboard with a scissors.
3. Bend a piece of 8 inch wire into the shape marked 1-2-3-4. (The wire used by florists to make corsages is fine for this.)
4. Cut the slits marked 5 and 6 in the body.
5. Scotch tape the wire to the body along 2-3-4.
6. Fold the front legs at line 7 and place into slit 5.
7. Fold the back legs at line 8 and place into slit 6.
8. Scotch tape 5 medium sized paper clips to the wire at end 1.

Now place the back legs on the palm of your hand and the horse is ready to rock back and forth, without falling off. After step 2, you may wish to color in the eyes,

* Based on letter sent to children who viewed the program.

II. The Roll Back Toy



nose, mouth, mane, and body spots on both sides of the cardboard.

1. Obtain a round, pint ice cream container.

2. Cut slits in the center of the cover and the bottom as shown in the picture.

3. Push a $\frac{1}{8}$ inch wide rubber band through the slit at the bottom and then cover the slit with a small piece of cardboard, to stop the rubber band from pulling in.

4. Tie a one ounce lead sinker (or other similar weight) to the center of the rubber band.

5. Push the free end of the rubber band through the slit in the cover as in Step 3.

6. Place the cover on the container.

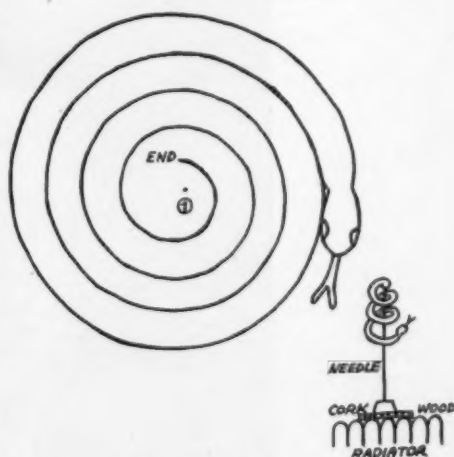
Now roll the container off in one direction and it will come right back to you like a boomerang. Decorate this toy with your favorite color designs.

1. Use carbon paper to trace the snake on light cardboard.

2. Use scissors to cut the snake around and around until you reach the inside end of the spiral.

3. Use the end of a knitting needle to make a dent in the cardboard at point 1. Be careful not to poke through the cardboard.

III. The Whirling Snake



4. Make a stand by pushing a 12 inch knitting needle into a cork which has had a small hole bored through it. Be sure to push the needle away from yourself.

5. Place the dent in the snake on the tip of the needle.

Now stand the snake on a hot radiator and watch it whirl around. Do not use an open flame for this toy. Can you figure out why? Make several of these snakes in different colors and use them to decorate your room.

JEFF WEST

THE 1954-1955 President of the National Council for Elementary Science was Mr. Jeff West. He presided at the annual meeting held at the Conrad Hilton Hotel, Chicago, Illinois, on March 5, 1955. He succeeded Professor N. Eldred Bingham, University of Florida, Gainesville, as President.

Mr. West was born in Hagerman, New Mexico, July 1, 1911. He graduated from the Hagerman High School in 1927. He attended Texas Technological College and New Mexico State Teachers College. In 1938 he received an A.B. degree from California State College at Chico. He did graduate work at Stanford University and

received an M.A. degree from College of the Pacific, Stockton, California.

He married Madge Dozier in 1933 and they have one son.

Teaching experience includes elementary schools at Dunsmuir and Stockton, California, and summer sessions at College of the Pacific (1947 and 1953) and Modesto branch of San Francisco State College (1955). Since 1946, Mr. West has been Supervisor of Elementary Science, and since 1947, Director of Audio-Visual Education, Stockton Unified School District.

Mr. West served as Second Vice-President of the National Council for Elementary Science 1950-51 and as First Vice-President 1953-54.



PROGRAM
NATIONAL COUNCIL FOR ELEMENTARY SCIENCE
THE CONRAD HILTON HOTEL

CHICAGO, ILLINOIS

Saturday, March 5, 1955

DEVELOPING A PROGRAM OF ACTIVE INVESTIGATION

9:30 to 11:30 GENERAL SESSION

Upper Tower, The Conrad Hilton

Presiding: Jeff West, Stockton, California,
President, N.C.E.S.

Welcome—Raymond M. Cook, Chicago Teachers College

Theme of the Conference

Clark Hubler, Wheelock College, Boston,
First Vice-President, N.C.E.S.

Address—"Spontaneity and Coherence in Elementary-Science Experiences." R. Will Burnett, University of Illinois

Panel Discussion

Meet the authors, discussing "*Books in an Active Program of Science*." Glenn Blough, University of Maryland; Sister M. Aquinas, Green Bay, Wisconsin; Kenneth Freeman, Teachers College, Geneseo, New York; Helen D. MacCracken, Estes Park, Colorado; Morris Meister, High School of Science, New York. Books by these authors are displayed on the table near the stage.

12:00 to 1:30 LUNCHEON

Lower Tower, The Conrad Hilton

Presiding: Muriel Beuschlein, Chicago Teachers College

A Lecture-Demonstration of Fire—The Science of Combustion:

Llewelyn Heard, Standard Oil Company of Indiana

(Send \$3.50 for luncheon reservation to Rolland Meiser, Chicago Teachers College, 6800 Stewart Avenue, Chicago 21, Illinois)

1:45 to 3:15 GROUP DISCUSSIONS

Each discussion will be initiated and conducted by the panel members listed.

1. *What methods, attitudes, and experiences are suitable in an active program of elementary science?* Room 521. George Mallinson, Western Michigan College of Education; Mildred Brandenberger, Danville, Illinois; Seymour Trieger, New Lincoln School, New York.

2. *How do children respond to an active program, and are the results commendable?* Room 522. Julian Greenlee, Florida State University; Mary E. Jones, Chevy Chase, Maryland; Lester Vanderwerf, Northeastern University, Boston.

3. *How can the logic of the subject be developed coherently, yet children be given freedom to plan and to investigate their own environment?* Room 523. Lewis H. Hollmeyer, State of Illinois; Marian Young, New Lincoln School, New York; Chester D. Babcock, Seattle.

4. *How can the essential books and teaching resources be obtained, organized, and used in an active program?* Room 12. Eleanor M. Johnson, Wesleyan University, Connecticut; Wallace S. Murray, D. C. Heath Co.; Eleanor Lester, Abingdon, Virginia.

5. *How can an active program of science deal with problems of community resources, their conservation and use?* Room 13. Richard L. Weaver, University of Michigan; Muriel Beuschlein, Chicago Teachers College; Ramon Swisher, Forest Preserve District of Cook County, Illinois.

6. *What training can teachers be given to aid in developing an active program in elementary science?* Room 14. Harrington Wells, Santa Barbara College, California; Joe Zaffaroni, University of Nebraska; Sister M. Evangelista, Nazareth Academy, La Grange Park, Illinois; Al Piltz, University of Florida.

7. *What can administrators, supervisors, specialists, and other leaders do to aid in developing a program of Active investigation in elementary science?* Room 20. Sister M. Celine, St. John College of Cleveland; Herbert Montgomery, New Castle, Indiana; Dorothy Dreisback, Louisville, Kentucky.

3:25 to 4:15 CLOSING SESSION

Upper Tower, The Conrad Hilton

Presiding: Jeff West

Panel Discussion

"*Conclusions of the Conference and the Outlook for Active Programs of Investigation in Elementary Science*." Ned E. Bingham, University of Florida, and representatives of the discussion groups: 1. H. Seymour Fowler, Iowa State Teachers College; 2. Beatrice M. Moore, Muskegon Heights, Michigan; 3. Elizabeth Cunningham, New Britain, Connecticut; 4. Emilie Lepthien, Chicago; 5. R. M. Ring, State of Illinois; 6. Charles Burleson, San Francisco State College; 7. Gilbert Rudiger, Des Plaines, Illinois.

SUNDAY, MARCH 6

9:00 to 11:00 a. m. ANNUAL BUSINESS MEETING

Room 3, The Conrad Hilton

Jeff West, President, and all members of the National Council for Elementary Science.

Program of the National Council for Elementary Science meeting with the ACEI in Kansas City, Missouri, April 16, 1955.

9:15 GENERAL SESSION

Welcome: A. W. Gilbert, Kansas City Public Schools

Address: "Science and the Child," Gerald Craig, Columbia University

Address: "The School and the Child's Science Interests," Katherine Hill, New York University

Demonstration: "Helping the Child Make Models for Science," U. S. Forest Service

Discussion: "What Does All This Mean to Me"

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February 1954-March 1955

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POINTS TO REMEMBER IN MAKING AN EXHIBIT *

C. W. MATTISON

Forestry Service, United States Department of Agriculture, Washington, D. C.

SKETCH OUT YOUR IDEA ON PAPER

FIRST obtain the dimensions of the space that is to be used for the exhibit. Then make a scale drawing, for instance one inch equals one foot of the space. With tracing paper overlays sketch out arrangement ideas, keeping in mind the sizes of objects to be exhibited.

SELECT A GOOD EXHIBIT SUBJECT

Instead of using many unrelated objects, try to tell a story which will hold the visitor's interest. For instance in a home canning exhibit as a center of interest, it would be effective to show how home canning methods have improved through the years. Photographs and actual containers

could be used. Features that are reminders of events such as picnics, holidays, et cetera, are timely and effective as attention getters.

KEEP IT SIMPLE

Do not overcrowd an exhibit with too many objects. It is better to select only a few and emphasize these by plain backgrounds.

SUGGEST LIFE AND ACTION WHENEVER POSSIBLE

People making things or giving demonstrations bring attention to the exhibit. Simple animation, such as an ordinary turntable also helps.

LIMIT THE READING MATTER

Use simple short legends. Long legends are not read by the average visitor, so the

* Summary of a paper presented at a joint conference of the National Council for Elementary Science and the Association of Childhood Education International at Kansas City, Missouri, on April 16, 1955

message is consequently lost. Remember that the average time a person spends looking at an exhibit is only one or two minutes.

USE INEXPENSIVE LOCALLY OBTAINED MATERIALS IN CONSTRUCTION

Visit your local lumber yard, department store and variety store to select materials for construction. Many times much assistance can be given in the selection of inexpensive materials by the employees of the concerns.

CHOICE OF COLOR IS IMPORTANT

Use your color to emphasize the center of interest in the exhibit. Obtain color charts from local paint stores and organize

the color scheme fully before starting to paint. Avoid raw, glossy colors.

LIGHT UP THE EXHIBIT

Ordinary lights can be used to illuminate the exhibit. Try to conceal the fixture, so there will be no glare. Focus the lights on the chief point of interest. Local electricians can help in the selection of suitable inexpensive lighting arrangements.

VISITOR PARTICIPATION IS EFFECTIVE

Attention is also brought to the exhibit if visitors can do something, such as pressing a button to see a picture; to look through a magnifying glass; to guess weights of objects, et cetera.

SPONTANEITY AND COHERENCE IN ELEMENTARY SCIENCE EXPERIENCES *

R. WILL BURNETT

University of Illinois, Urbana, Illinois

THE issue which underlies the title of the address I have been asked to make is as perennial as any issue discussed by elementary science teachers. On the one hand are those who insist that spontaneity—the very life blood of science instruction—is sapped from the program that is preplanned by the teacher or dictated by textbooks. On the other hand are those who point to the transience of children's interests and who believe that these interests cannot provide a sound basis for a program that is developmental in nature and leads to durable and worthwhile science learnings. Many are found in the middle ground between these two positions, of course, but even they seem generally to lean first one way, then the other, as the winds of the old argument blow around them. Perhaps it would be fair to say that most elementary teachers assume that some sort of

unfortunate compromise must be made between spontaneity and coherence in elementary science experiences and that these two things are necessarily in sharp conflict. To the extent that you have one, you haven't the other. Fundamentally, you cannot have both. For these teachers the conflict is as real as that which Dan Bennett mentioned: One guy wants to be a jet pilot—the other guy wants to be a concert pianist—only they are Siamese twins.

I do not believe that a conflict need exist between spontaneity and coherence in elementary science experiences. Nor am I taking the middle ground of the compromiser. I simply believe that this electric, effervescent, powerfully motivated interest of the child which we call spontaneity is the only possible basis for real coherence of learning activities. Desirable consistency and development of learning activities are impossible unless based upon the inherent impulses, promptings, and desires of the child. Spontaneity and coherence

* Paper presented at the meeting of the National Council for Elementary Science, the Conrad Hilton Hotel, Chicago, March 5, 1955.

are the Siamese twins of successful elementary science experiences. They are but two dimensions of the same thing for the experienter—the child. It is the teacher who tries to separate them.

So that you may understand what I am talking about, let me tell you about a third grade class. I have published this account elsewhere and I ask your indulgence if you are already familiar with it. Listen to it with this question in mind: Was either spontaneity or coherence missing from this classroom? †

"Two small boys had had a wonderful experience. They had gone with their dad to an airport in a small town and had spent the afternoon taking plane rides. It occurred to them that it would be fun to make a play airplane big enough to sit in or on and with workable controls. All the kids of the neighborhood finally got in on the project, and, with a little adult help the plane was built. A piece of wood about seven feet long served as the fuselage. Other boards were nailed here and there to form the wing, rudder, and elevators. The handle of a croquet mallet formed the "stick." Rope and wire ran from this to pieces of wood that were hinged with bits of leather and formed the ailerons and tail assembly. Oddly enough, despite the nails sticking out and the general crudity of construction, it looked like a plane. It wouldn't have flown in a hurricane but somehow the children had caught the feel of an airplane and no one could have missed knowing what the thing was.

"A string fastened to a wooden knob became the throttle and controlled the speed with which the propeller (the blades of an electric fan mounted at the front) turned. The plane was ready to fly. And fly it did, in the minds of those children. It flew so well, in fact, that the children's enthusiasm spilled over in the classrooms the next day.

"Two of the children—I'll call them Michael and Winnie—were in the third grade. The third-grade teacher encouraged and stimulated a great deal of active investigation in her classroom. The room was fun to be in. In one corner of the room was a small cage which had two compartments in each of which was a white rat. A kitchen scale sat on the table beside the cage and beneath the table was a box containing various food mixtures. A committee selected by the class had the responsibility for carrying on the diet experiment for each week and did the weighing and feeding as well as the reporting to the class.

"In the back of the room some orange crates were arranged to form a series of compartments

for the storage of materials, equipment, and references. Painted by the children as their whimsy dictated, these orange crates were delightful to look at. Among the several exhibits was a collection of sea shells brought back from Florida by a member of the class. The children had used a simple identification guide and had labelled most of the shells. The boy who had collected the shells had told them interesting stories about how the live animals had looked and acted that had once inhabited the shells. The children had written imaginative stories about life under the sea. Simple stories, to be sure, and sometimes dictated to the teacher, but creative in the best sense of the term.

"Batteries, growing plants, insects, charts, stories, paintings, magazines, tradebooks and text books, cut-outs, pamphlets, hand tools, lenses, bottles, cans, boxes, a bicycle pump, an old Erector set, dozens of toys—this is a brief and inadequate picture of the third-grade classroom where Winnie and Michael started to tell their classmates about the airplane they had built. It was not precisely a neat room but it was a beautiful room. It was particularly beautiful when it was full of children working on all sorts of projects: reading, writing, drawing, telling stories, investigating, experimenting, and getting answers to their endless hows and whys.

"It was the kind of room into which a rather large and clumsy wooden airplane could be brought and made to look at home. As Winnie and Michael told of their airplane the teacher observed the listening class with interest.

"Would you like to see their airplane?" she asked.

Indeed they would. Would Winnie and Michael like to bring their airplane to class? Nothing would have pleased them more.

"When the airplane arrived the next morning all of the chairs were pushed aside so that it could have the center of the room. Mike and Winnie demonstrated how the plane worked and showed how the controls operated to make the plane perform in the air. The teacher had located several pictures of airplanes, one of which showed the action of the control surfaces relative to the flow of wind.

"The teacher had done additional homework. She had called a friend who flew a small airplane and she had called the local airport to determine if it would be possible for the children to visit as a group. She had found a number of references that showed her how to illustrate and demonstrate various phenomena related to typical questions of children about an airplane and how it works. Instead of taking the class's spontaneous response to Winnie and Michael's airplane as an opportunistic feature of transient interest, she had planned an educational campaign based upon both the children's obvious interest and the possibilities of their educational growth.

"Here are some of the thoughts, problems, questions, opportunities, and tentative plans that the teacher had sketched in her mind as she thought about her children and the airplane. 'Joey reads very well, and almost too much. He still shows

† The following is slightly adapted from Burnett, R. Will. *Teaching Science in the Elementary School*, New York: Rinehart and Company, 1953, pp. 24-32.

shyness and seems to prefer to be off by himself. There is a possibility that Joey will show sufficient interest that I can get him to take on responsibility for others in the class in helping them to find the reading materials that I can make available. If he would only find a close pal.

"All of the children ought to profit both in reading development and in writing if I can find some materials so pictorial and simple that even Marie will enjoy them. Even poor little Raymond might show some lessening of his bravado and the other children might accept him better if I can find some way to get him to feel less self-conscious and inadequate. I've tried a hundred times without evident success but I might as well keep trying.

"Then, again, I ought to be able to figure out something so that the whole group will take over more completely in planning out just what they would like to learn about airplanes and aviation. They've been showing amazing growth but I still need to give them more experience in working together *responsibly*! But, after all, they're awfully little kids. I suppose I'm always expecting too much of them.

"But if I do put this thing in their laps I've got to be very sure that I get them really excited about some things that are truly important. If only I could get these little people to begin to think a bit about how the airplane has changed, and is changing, our whole pattern of living. If only they could see—or at least begin to sense—that it is *really* one rather tiny world we're living in today. I just can't believe that it is safe to wait until they are in the high school to get them sensitized, at least, to the ideas of cooperation; the fact that we've got to be concerned about people in other lands. And I've got to be very sure that I set things up so that they can actually investigate on their own—and get satisfying and sound answers they can understand to the many questions that are sure to come up. The high school science courses are soon enough for them to get an organized picture of the sciences as such. But I want the answers they get to their present questions to mean something more than just answers. If I work this right I can help them to form some generalized insights, at least—to get some feel of important principles that they can build on from now on.

"Something to build on. That's about it, I guess. To be sure that they are always learning in such ways that they've got something to build on. If I can help them learn how to learn—if I can help them increasingly to investigate on their own steam—and think for themselves—then, maybe, I've done the most important thing I can do for these kids. Well, I guess I'll just relax and see what happens. At least I know what I want to happen!

"Here is what happened.

"All of the children had to have their turn, of course, in flying the airplane. At first the room was quiet except for giggles and sounds remotely suggesting the whine and roar of aircraft engines. But after Michael had demonstrated the airplane and had told the children what he could about how

the controls made the airplane change its position in the air, the babble began.

"In real airplanes there's two things on each wing that go down—the stewardess pointed them out to me." This from Tommie.

"My Dad says that planes can go even faster than sound—you can't even hear them." This from a small head stuck in between two chairs as its owner attempted to look upside down at the plane's tail.

"Aw, he's just talking about jets. They fly over here all the time."

"How come jets make smoke lines in the sky?"

"They ain't smoke lines. That's like steam—isn't that so Mrs. Stanley?"

"I've got a plane that will really fly. I got it for my birthday and it really flies."

"What makes a plane go so fast?"

"How many kinds of planes are there?"

"Are you afraid in a parachute?"

"Are there any roads in the sky? My daddy said they go on paths in the air just like on the ground."

"Do they stick their hands out when they're going to turn?"

"How does a plane dive?"

"Where do planes go?"

"Can you go to the bathroom in an airplane?"

"Why are the engines so noisy?"

"Can you keep going up and up and up and up?"

"So the questioning went—on and on and on and on. Without much evidence of unity or design, one question seemed to elicit another that might be related or that might be a prime example of a *non sequitur*.

"Answers were given almost as frequently as questions were raised. Everybody wanted to talk at once, it seemed, and through it all the wooden airplane was 'flown' constantly, was patted, was stared at, was touched, was wiggled. Every so often an imagination would become too strong for the room's confining reality and a little pilot would buzz noisily as he raced down the runway to the corner of the room and took off without benefit of even the wooden plane.

"Could we go out to the airport and see the real planes like Mike and Winnie did?" queried Raymond.

"Here was a bit of a break. Raymond was the child she had wanted to head some project for his ego's sake.

"I'll tell you what let's do. Raymond. I don't know the number of the airport offhand but here is the way it is listed in the phone book. Mr. Stonecipher is the man in charge out there and he is awfully nice about having people visit there. If you will run out to the phone and call him I don't see any reason why we couldn't go out."

"Raymond stared for a few seconds, decided it was a good idea, and bolted for the door. Mike got into high gear and ran after him.

"Where are you going, Mike?" called the teacher.

"Oh—I was going to help Ray. I've been out there."

"Sure, I know you have, Mike, and that is why

I want you to tell us what you can—you too, Winnie—about what you think we might like to see and do at the airport. How many of you have been out to the airport—I mean, have had time to really look it over so that you can help us plan what we ought to do in preparing to go out there?"

"Susie, Kim, and Leonard wigwagged furiously that they were competent old-hand partners in the airport enterprise.

"All, right," said the teacher, "how about having Susie, Kim, Leonard, Winnie, and Mike draw up a list on the board of the things they think we would like to see out there? They can be our planning committee."

"I want to see what the inside of a wing looks like when—"

"A veritable storm of suggestions broke out.

"Wait a minute, wait a minute," said the teacher. "I guess we had better ask the committee to take over right now and, instead of going into a huddle by themselves, take a little time getting all our suggestions down on the board. Susie, suppose you and Winnie write the questions down on the board—that way we can move faster. Kim, you handle the questions. It seems to me that we had better not try to discuss our questions now but just get them listed so that we can plan our trip better.

"Now," continued the teacher, "while you are getting your questions out and getting them listed so that we won't forget them, suppose that I try to find what help we can get from the books and things that we have in the room and in the library. Maybe it would be a good idea for Miss Roberts [the librarian] to come in, if she can, right now, so that she will hear the questions you have and perhaps she can suggest books and materials that would help us.

"Joey," she went on, "do you suppose that you could go down to the public library after school today and find out what they've got there that would help us? I think that Joey ought to do this because he gets books from the library all the time and really knows his way around there. Mike, suppose you and Joey do that together—you have been out to the airport recently."

"I was out there just yesterday," said Leonard.

"Oh, really," said the teacher. "I'm sorry, I didn't know that."

"Sure, I'm out there a lot."

"Fine. Then, suppose that you and Mike work together with Joey in getting a list of materials that the city librarian thinks we might find useful. Joey can show you your way around at the library. Will you do that, boys?"

"There is another thing," continued the teacher, "I know a man who flies an airplane—he actually owns one. He has promised me that he would be glad to come in and tell us all about how it feels to fly a little airplane. And it seems to me it would be a good idea if he knew the questions we had, too, so he would know what we wanted him to talk about. Who would like to call him tonight and tell him—"

"The sentence was never finished. Raymond

burst into the room, bubbling over with his good news.

"We can fly, we can actually fly. He said we could. He said if it was all right with you and our folks we can actually fly."

"When the 'ohs,' 'ahs,' squeals, and 'yippies' had subsided the planning began in earnest. Each child volunteered for or was delegated to a position of responsibility in moving the work forward. A committee was set up to help the teacher try out some demonstrations that the committee members would then present to the class. Detailed plans were made on the problem of timing. Letters had to be written to the parents explaining the nature of the proposed trip and requesting their willingness to have their children take a short flight. The teacher prepared a covering letter to go with that drawn up by a student committee, later improved by the class as a whole, voted upon, and separately written by each child to his own parents. The teacher later took a small committee of the children out to the airport to work with Mr. Stonecipher on the details of timing the trip. They later presented a chart on the board showing just what they would see in a timed sequence. Other letters had to be written to the state department of aeronautics asking for certain materials and for answers to some questions. A letter was sent to the teacher's air-minded friend asking for his help on a certain day and suggesting the problems that the class wanted information about.

"The demonstrations and experiments were varied and many. The boy who had a plane that would 'really fly' brought it to school and demonstrated it. This focused interest on the common question 'What makes planes fly?' and the demonstration committee went into action. A curved paper was held up and Annabelle asked the class what would happen if she blew her breath 'hard'—over the top of the paper. To the great glee of the entire demonstration committee everybody thought that the paper would go down. The class was lost in admiration and awe when the paper moved up in the path of the blown air.

"That's crazy—let me try it."

"How does it do it?"

"That's nuts!"

"The committee members had the class right where they wanted it. They took the wraps off other experiments equally puzzling. Then they turned to charts they had prepared that showed how a baseball curves when thrown a particular way, how the same phenomenon explained the 'no-draft' ventilators in a car, and how it also accounted for the fact that a giant airplane weighing many tons could roar down the runway and take off. The puzzle began to unravel. With various degrees of insight the children began to get the idea of 'lift.' Not as an aeronautical engineer would see it, to be sure, but with the personal satisfaction of understanding the cause of an interesting phenomenon.

"A paper plane suspended by a thread was placed in front of an electric fan. The paper ailerons and tail assembly were placed in various

positions to show how the rush of air could cause a plane to dive, climb, bank, and turn.

"A milk bottle 'altimeter' was taken from the basement floor to the top floor of the building and the children noted the slight drop of the soda-straw pointer as the outside pressure lessened on the rubber balloon cap to which the pointer was glued.

"The day came for the trip to the airport. Each child was given a ride in the front seat of a small airplane with an instructor behind him. Each child was allowed to handle the stick and to make the airplane turn, climb, and dive. They all saw how an airplane is made. They listened to the dit-dah, dit-dah, dit-dah of the radio beam. They listened to a pilot talking to the airport over his radio. They observed the work of the ticket man and they watched commercial planes being loaded.

"They did many things. They had a marvelous time. They saw real altimeters and saw that these were made very like the one they had made. They looked at the air charts and saw how the radio beam they had heard enabled a pilot to fly 'on paths in the sky' that, although invisible, were as exact and helpful as marked highways on the ground. They observed a small plane fitted with a spraying system and used for spraying farmers' fields. The trip was an educational experience of high worth, but it was of even greater importance as a motivating and sensitizing experience leading to the possibility of even more rewarding educational experiences later on.

"Did the teacher succeed in her wish that she could help the children become increasingly aware of the fact that the airplane and modern systems of communication had made the world one? Did she realize her goal of having her children become aware of the need for international understanding and cooperation?

"Of course she did. Not, perhaps, to the degree of verbal and explicit recognition that she had subconsciously been hoping for. For, after all, as she had mused in planning the unit, these were but little children.

"But she had done a good deal. When the children planned their 'trip' to South America by airplane they had learned a good deal about the 'one world' the airplane had brought. They found that their airplane would have to be sprayed to prevent any insects from traveling from one country to another. The teacher helped them to understand how the airplane had played a large part in the setting up of the World Health Organization in the United Nations to take care of such problems as these.

"As the children studied the speeds with which planes now fly and the distances they go, they covered a twelve-inch school globe with colored strings stretched between various points on it and with labels indicating how long flights between the points would take.

"A chart was prepared comparing the time required for pioneers to travel in the frontier days, for ships to cross the seas prior to the age of flight, and to show how the airplane has changed the world because it has telescoped time.

"The teacher had achieved much. She had

added the children's interest in finding out about things to her vision of what the children needed for growth in the way of educational experiences. She had taught science. And through science she had taught reading, writing, and arithmetic and, by and large, the children had really read, really written, and really quantified. They had learned a good deal about how to get along with each other, about how to plan, about how to share the work, about how to accept responsibility and discharge it. They had learned about their interesting world. They had learned, through real living, a little more of what they would have to learn to live happily in this world of reality.

"Raymond was still Raymond and Joey was still Joey. No miracles had occurred. But the year wasn't over. There was still time.

"The teacher pulled a third-grade reader from her desk drawer and idly turned the pages. Her attention focused on a sentence in a unit on airplanes to which she had subconsciously turned.

"Airplanes move faster than the wind," it read. "By air, we can now travel to any place on earth in less than sixty hours!"

She had once thought that this was an outstanding book. "As a matter of fact," she mused, "it really is! We used it a lot on our unit."

"But the sentences in the book now seemed so flat when she compared them with the tremendously rich experiences her class had just had. In a way the book's unit on airplanes covered the same general ground her class had just covered. 'Covered nothing,' she thought. 'That's precisely the difference. We didn't 'cover' anything. We did some real and interesting work together. We used some of the material in this unit and a lot more from a hundred and one other sources. But we never quite thought of 'covering' anything. We were having honest-to-goodness real experiences together. The trouble with a book like this isn't a fault of the book, actually. It's the fault of us teachers who forget that our children aren't living out of a book. They are living a life, and the books are important to them as they have experiences in which the book will give clarity or meaning or emphasis.'"

"They are living a life." The children are living a life. Here is where coherence lies. It is the job of the school to relate its work so intimately to children's lives that those lives become richer, fuller, healthier, and more stable and satisfying. Coherence in a school program is meaningless except as it refers to the need of coherence in a child's life outside of school.

Forgive me for dwelling so lengthily on this third-grade class. I find I can see theory most easily through living examples of the theory in operation. Perhaps we are all like that. Here is what I have learned

from this class and from watching other good teachers working in a similar fashion with children.

I have learned that real and durable learnings in the elementary school usually grow out of real life experiences. These third graders could have learned something about aviation by studying the same texts at the same time and in the same way. But it would not have been the same kind of learning. I doubt that it would have affected behavior greatly or been long retained. What they did learn was out of life. The teacher and books and the school served as media whereby the children could investigate their real-life world and reflect upon it with increasing insight.

I have learned that spontaneity in an elementary science program need not imply loss of aim or lack of coherence. The third grade teacher I have pictured allowed great flexibility in her class and permitted different avenues to be explored by her different children. She did not make the mistake of assuming that identical activities for all her students provided identical experiences. She knew that her children varied in many ways—in intelligence, in reading ability, in interests, and in backgrounds. So she stimulated and challenged her students to follow their interests while seeing to it that they were all helped to grow in certain common fundamental skills, understandings, and attitudes. Coherence lay in the fact that the teacher was teaching science for more coherent lives and realized that a developmental program leading to this goal must be different in its details for each child—according to the differences in his needs and desires. Seeing her goals clearly she could permit learnings at different speeds and at different levels of penetration.

I have seen some teachers who would have taken this original interest of two children in airplanes and dealt with it opportunistically and without building upon the spontaneity that comes from real life experiences. Such classrooms soon descend into chaos and I fear for positive

learnings. But such classrooms exist chiefly because the teachers have not seen the potential of the man in the child nor the educational promise in the immediate interest that the child brings to the classroom. Bluntly, such teachers do not understand the purpose of their offerings. They teach the immediate and specific without drawing upon it to lead young minds to generalize and reflect and relate to life.

Such teachers are matched by others who attempt to extrude their various young charges through a common educational die. Completely planned and ordered for all by the text or the teacher, the educational activities in such classrooms neglect living experiences of the child and tend to be heavily verbalistic. They are often text reading programs backed up with a few desultory demonstrations by the teacher. They are the result of the same professional defect in the teacher that produces opportunistic programs that go nowhere. The defect is an absence of clear goals or a confusion as to the values inherent in science activities. It often includes a lack of understanding of the nature of learning.

I have learned that coherence in learning is a highly individual thing. And I think that it is coherence in learning rather than in a program that we should be thinking about. We can develop a program or write a textbook that shows excellent logical coherence to the mature person who already understands what is in the program or the text. But such a logical development of science content and activities does not represent coherence in a child's experience or in the learning that will result when the child applies himself to the program. A program so based will short circuit the thinking of one student, baffle a second, and bore a third. Yet each of the three could profit, and might be brought to work near optimum capacity, on the same general body of science content and activities if these grew out of their own backgrounds of experience and interest and if the children were allowed freedom for different types and levels of exploration and investigation. I am sug-

gesting that programs which are completely pre-planned and tightly ordered provide neither for desirable spontaneity nor for real coherence. Such programs are difficult to relate either psychologically or logically to the experiences and growing insights of the assorted children typically found in an elementary classroom. They can therefore relate but tenuously to the child's daily life wherein the possibilities of cohesion in learning *really* lie.

All this depends, of course, on what we are after in teaching elementary science. If our purpose is simply to expose children to science as an organized body of tested data, then the thesis won't hold water. But I think that the third grade teacher was after the right things. She was interested in the intellectual, social, ethical, and emotional maturity of her children. Science was a tool in the process of developing that maturity.

Intellectually, she was concerned with growing powers of thoughtful inquiry, the use of an increasingly wide variety of references, and understanding of the real world outside the classroom. She wanted to bring her children ever nearer to an understanding of the tested facts and the important principles that represent the results of scientific inquiry. But she wanted these facts and principles learned in such ways that they would become a part of her children and used by them in the affairs of life. She wanted her children to grow in their understanding of science as a critical form of inquiry. She wanted them to savor the satisfactions of securing reliable data and resting conclusions upon them. She wanted her children to develop as fully as possible in understanding of the phenomena that lie behind social, economic and political problems with which they must some day wrestle as responsible citizens in a democracy become a world power. She knew how science activities could be used to develop these things as well as to develop increased power in reading, writing, and arithmetic.

Socially, she wanted her children to

grow in skills necessary to a people in a democracy. She recognized that the skills of democratic social intercourse are complex and must be learned and practiced. She knew, too, that children's many whys and hows about their natural world provided a magnificent motivation basis upon which to provide for group work, develop individual responsibility to the group, and to increase communication powers.

Ethically and emotionally, she was concerned that her children come to know the morality of consequences—and that, even under the uncertainty principle of modern science, causation operates in such ways that the world may be understood, ordered, and even controlled to a great extent. She wanted the children to grow in stature—to find their strengths and to overcome their weaknesses. The hurt child, the shy, the bully, the egotist covering his feelings of inadequacy with bravado—these were her concerns, too. She knew that she taught more than the brain. She was responsible for doing her best with the loving, hating, fearing, thirsting entire child that was Raymond, or Winnie, or Joey or Mike. And in all this she saw how science activities could be wedded to the other activities of the elementary classroom to provide a life-based program as integral and cohesive as life is to the individual outside the classroom.

Now it may seem that I have wholly neglected the most fundamental problem in this supposed issue of spontaneity versus coherence. You might say, "Well, suppose I buy this idea of coherence through guided development of spontaneous interests in a single classroom. What happens as such children move up through the grades. How can there be an adequate scope and sequence which will avoid redundancy and gaps in the education of children?"

Frankly, I cannot get concerned about gaps, if by that you mean gaps in science details that otherwise would be covered by the exclusive use of a textbook approach. I am not concerned for three reasons. In

the first place, a teacher who understands the place of science facts in developing mature young people will use whatever facts are pertinent to the ongoing program for these larger ends—which are the important ends of elementary instruction. In the second place, any teacher who provides for both spontaneity and coherence of the sorts I have described, will inevitably deal with the really important facts of science. What are these important facts? Why, they are the facts that are needed to answer the questions that are important to the learner engaged in the kind of flexible yet developmental program I have described. In the third place, I am not concerned simply because I am aware that even the most detailed and intensive program that attempts to cover as many facts as possible cannot really make a noticeable dent in the body of science that exists in the archives. When we say we “cover the book” we shouldn’t kid ourselves into thinking we have covered the science. I am not concerned about coverage. What I’m really concerned about is the common *attempt* at coverage which inevitably means that children learn but superficially. I would much rather that our children learn well what they do learn at whatever expense to coverage.

The question of possible redundancy rests on something more real. Perhaps the teacher in grade six doesn’t know that the third grade teacher had quite a unit on aviation. And she has several children who moved into the neighborhood and were not a part of the third grade class which studied aviation. Suppose that some of these newcomers suddenly get excited about airplanes. What then? If the teacher takes over and decides what is to be done and how it is to be done we are faced with a real problem. But not if the teacher works in the general manner of the third grade teacher. For by encouraging student participation in planning the work she will find quickly enough the knowledge and the interest that the various members of the class have in aviation.

But at best won’t this mean that the children will either go through the same unit again or else decide against such a unit at the expense of the newcomers? I doubt it very much. Sure, they might decide on a unit on aviation. But it won’t be the same unit if these children are a part of the planning. They didn’t learn all there is to know about aviation in the third grade. Perhaps they learned about all they wanted or needed to know at that time. But they’re older now and have had many experiences. They are capable of building on the former learnings. And the newcomers as well as any of the former third grade class can, under this conception of teaching that encourages spontaneity, learn from activities and materials as simple as need be. The most informed can still learn much, too. After all, aeronautical engineers are still learning. Why do we have to set single standards of accomplishment by grade levels when we know they are illusory?

On the other hand I wouldn’t be at all annoyed or concerned for the newcomers if the class decided against working as a group on aviation. If the teacher were like the third grade teacher, the newcomers would be given plenty of opportunity to learn about aviation while they and the whole class worked other ground. And even if they never had an opportunity to study aviation formally in the classroom I shouldn’t be shocked and feel that their educational souls were in jeopardy of hell fire. They wouldn’t have time to study everything in school in any event. The really important thing is that they have teachers who help them increasingly to learn on their own steam, to develop self discipline, to learn how to study and investigate and to know how to get at references and use them profitably. I cannot accept a hierarchy of science content as representing relative importances for these ultimate goals.

I started by stating that spontaneity is the only possible basis for real coherence of learning activities for the individual

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learner—and therefore for any class. I'll finish where I began. In terms of the goals of elementary science education I accept as valid, I cannot accept a divorcing of the two. Coherence we must have if our science instruction is to develop mature individuals. But it cannot easily be devel-

oped under the specious orderliness of programs that neglect the necessary spark of real learning—the spontaneous, inherent, probing curiosity of the child, that develops out of real life experiences. Not, at least, for the goals I want achieved for the two little boys in my own home.

THE SCHOOL AND THE CHILD'S SCIENCE INTERESTS *

KATHERINE E. HILL

School of Education, New York University, New York, New York

IN considering the school and the child's science interests, perhaps we should consider a basic truth which we sometimes overlook. This is that a child has interests which probably may be classified as science interests from the time of his birth. For example, an infant becomes curious about noise and light quite early. His eyes follow a moving spot of light. He is startled by an unusual sound. He responds in a pleased manner to other sounds.

Certainly, as he grows older, a child is obviously curious about many aspects of his environment. He handles any object within his reach. He prods it, throws it down, picks it up again—sometimes to our great annoyance. Whether he is interested in these objects mentally, we have no way of knowing. But certainly, some kind of interest is evident.

Later, while a child is still of pre-school age, these interests broaden. Again, they may seem destructive to us, as adults, especially when this child pulls up spring flowers by their roots. Or his curiosity and interest concerning height may frighten us as the child performs greater and greater feats of climbing. An active, healthy three or four-year-old evidences interest in his

environment almost every waking moment. These interests are amplified by the continual "What is it?"s and "Why?"s that he asks.

It is apparent, then, that the school is not responsible for producing a child's initial interests in scientific phenomena. Rather, our problem, as educators, is to encourage children to continue these initial interests, to develop these and other interests, to explore new avenues of interest.

Perhaps the first requisite for a program of education which encourages children actively to explore scientific phenomena is teachers and administrators who are aware of, and stimulated by, these same phenomena. The teacher who said, in explanation of the lack of a science program in her classroom, "No, we don't have much science. I guess I'm just not interested." put her finger on a fundamental, if not *the* fundamental, shortcoming in her program of science education. Unless the adult in the situation is stimulated by a child's excitement concerning the environment and unless the adult is willing to and capable of stimulating a child's curiosity concerning other aspects of this same environment, there can be little give-and-take between adult and child in this respect.

The teacher who is stimulating in the area of science will see to it that children have a chance to explore several aspects of their environment during the year. For

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example, she will be loathe to insist that her group spends the entire year studying "Stars" and "Insects." Instead, she will open new science vistas in various ways from time to time during the year. She will throw out questions, set up bulletin boards and displays, share informative written material, and suggest observations and activities which will spark new interests and efforts on the part of her group.

This teacher will see to it that children have an opportunity to explore a variety of questions during the year. A possible list might be: "What are some of the bodies in space? Could we travel to them?", "How do animals in our community live through the winter?", "Could we learn to predict the weather?", "Has our community always looked the same as it does now? Have the same hills, rivers, plants, and animals always been here?", "Could we make telegraph sets and send messages from one room to another?", and "What can we do to stop erosion on our school playground?". To be sure, the entire group will not make an exhaustive study of any one of these questions. But in exploring these areas, it is possible that more children will be stimulated to explore more deeply than would be possible if their study should be limited to a consideration of "Stars" and "Insects."

The teacher who is stimulating in the area of science will provide adequate materials for the use of children. First, let us consider the environment. Certainly the environment is always present, but it can be *present* without provision for its *use* by children. Sometimes the environment outside the classroom is provided for children by merely allowing them to observe this environment from the windows of the classroom. The effects of a rainstorm, the kinds of clouds, the direction of the wind, the signs of approaching spring often may be detected without physically moving into the out-of-doors.

But we can provide the environment still further for children's use by exploring with children the area outside the four walls of

the classroom. Perhaps the group will need to visit the community's electrical generating station or the nearby boiler room of the school. Perhaps the exploration will take the group to a wooded area several miles from the classroom to observe plant and animal life there, or it may take the group only twenty feet from the school building to observe several kinds of shrubs and trees which have swelling leaf and flower buds. The point is to make the environment available for exploration so that interests may be fulfilled and/or stimulated further.

Provision for exploring interests within the classroom must not be overlooked. Such necessary science materials as balloons, bottles and jars, boxes, candles, cellophane, compasses, corks, doorbells, dry cells, dyes, flashlights, glue, hot plates, knives, magnets, matches, mirrors, nails, paint brushes, paints, paper, pots and pans, salt, saucers, scissors, spoons, sugar, tin cans, tongue depressors, toys, vinegar, and wire must be a part of the classroom science environment. Many of these materials will be provided almost overnight by children who are *allowed* to provide and *make use* of such materials. The cost of the few science materials which must be purchased from time to time amounts to a trifling sum when we think of the importance of educating our children. It goes without saying that space must be provided for these materials and their use. Closed cupboards or open shelves, as well as a table, are as important for the storage and use of science materials as they are for the storage and use of books.

And of course, we must not forget written sources which are so necessary in aiding children resolve or pursue questions which stimulate them. A most encouraging sign of the forward movement of a science program for children in the elementary classrooms of this country is the amount of written material now available for those children. By and large, our children do not control the money for the purchase of printed science materials. We

adults—we teachers, administrators, and parents—must be aware of the curiosities of children concerning scientific phenomena and must feel a good deal of responsibility to help satisfy those curiosities. Else, why would the number of science books being printed for children have increased so phenomenally in the past ten or fifteen years? Some time when you have a spare moment, consult the Children's Catalog for 1940, 1945, 1950, and 1955. The increase in fine science books for interested, curious children is most encouraging. Or examine recent and older editions of encyclopedias for children. Here you will find the same story. Educators are aware of children's science interests and are preparing materials which may be used by children as they attempt to resolve their curiosities.

Or, consider the films and filmstrips available in the area of science at the elementary level. Again, the same story is told. Educators are alive to the interests of children.

The question today is not "How will I ever be able to find materials to satisfy the science curiosities of the children in my group?" It is, rather, "Am I sufficiently aware of the driving, motivating interests of children in the world about them to see to it that an environment for exploration is provided both inside and outside the classroom?"

The teacher who is stimulating in the area of science will provide opportunity and freedom for children in the processes of exploration and sharing, both as group and individual experiences. Third graders had this opportunity during a study of "The Sky Above Us." Bob, as an individual, read material from several science books because he was interested in comparing facts concerning the solar system as set forth by various authors. He discovered what he believed to be an error in one of these sources and was encouraged to write the author concerning this error. At the same time, the children, as a group, were interested in constellations and proceeded with their study as a group. This study in-

cluded the use of books and films, an evening field trip to observe a few winter constellations, the making of oatmeal-box planetariums, and the recording of some of the subsequent learnings on a homemade "movie." There was a mutual sharing of learnings concerning the bodies in the sky with a fourth-grade group which was interested in this same study. In this instance, the teacher of the third grade was wise enough to provide ample opportunity for exploration and sharing. This is not always easy to do in a crowded program, but time can be found for such opportunities if the teacher values forwarding of children's interests in science.

The teacher who is stimulating to children in the area of science must attach sufficient importance to science experiences to provide an opportunity for their evaluation. The program which lacks time for evaluative procedures is often one which lacks continuity. Plans for next steps must be made not only by the teacher, but by the group as a whole. How else will children grow in knowing how to apportion their time and energy? How else will a teacher know which interests are fleeting and which are those of vital importance? How else will a group and the individuals in that group learn to consider and value group and individual contributions? How else will plans for next steps, which are reasonable ones for the group to pursue, be made?

Finally, the teacher who is stimulating in the area of science will provide opportunity for creativity. At times, periods of active, physical creativity on the part of a child are interspersed with contemplative efforts. A Kindergarten teacher recognized this more quickly than her student teacher one day as five-year-old Nancy sat in a chair staring into space, while all the other children were involved in obvious physical activity. The student teacher became so concerned about Nancy's quietness that she inquired of her several times as to why she wasn't working as the other children were. At last, Nancy, on the verge of utter ex-

asperation, said, "Can't you see I *am* working? I'm *thinking*!"

Allowing children to follow creative bents requires patience, guidance, faith, and good humor on the part of a teacher. But we know that one of the surest ways to kill interest in science is to pay little heed to a child's creative efforts. Soon his physical, verbal, and mental attitude becomes, "What's the use? At least, what's the use in school? I'll wait until school is over to find out what I want to know." Creativity is one of our most precious assets in a democratic society. Perhaps we should ask ourselves "Am I requiring too much con-

formity? Am I allowing enough time and space for the creative resolution of interests in scientific phenomena?"

We see, then, that this question of the school and the child's science interests is not a simple one. A consideration of the question causes us to review not only our total science program, but our total efforts in the education of elementary-school-age children. Because we have turned our attention to this problem briefly, perhaps each of us will make an effort to evaluate our part in helping children resolve and further their interests concerning scientific phenomena in the world around them.

WHAT HAVE BEEN THE MAJOR EMPHASES IN RESEARCH IN ELEMENTARY SCIENCE DURING THE PAST FIVE YEARS? *

JACQUELINE BUCK MALLINSON

Kalamazoo, Michigan

INTRODUCTION

IN reviewing recent research in elementary-science education, one is impressed by the increasing number of studies that are being produced. For many years the number conducted was few. For example, from 1929-52, less than four such studies per year, on the average, were published. However, during the school year 1952-53, seventeen were published, and during 1953-54, nineteen. Hence, one may assume that more research is being undertaken in this area than formerly.

In a review of this type it would be impracticable to discuss all the research studies published. Hence, an attempt will be made to point out the types of studies most commonly undertaken and to summarize the general findings.

The vast majority of studies published recently may be categorized in four prob-

lem areas, namely, (1) the status of elementary science, (2) the grade placement of science topics, (3) methods of enriching the curriculum, and (4) the training of teachers.

The Status of Elementary Science

Elementary science has been the subject of a great number of "status" studies. These investigations attempt to determine the scope of elementary science, the topics taught, and the most common teaching techniques employed. In general, the data are obtained by surveying courses of study, sending questionnaires to science teachers or supervisors, or observing classroom situations. In one such investigation courses of study published from 1940-52 were analyzed and their contents were synthesized into a "subject-matter content guide." In another study 1,246 elementary teachers were interviewed to determine existing practices. Many other studies followed similar techniques.

* Presented during a panel discussion on "Needed Research in Elementary Science Teaching" at the NARST Convention at Teachers College, Columbia University, April 18, 1955.

All these studies seem to point to the fact that the nature and importance of elementary science is now fairly well established. Also, there appears to be agreement with respect to the major topics generally studied.

Grade Placement of Science Topics

Closely related to the status studies are investigations concerned with the grade placement of science topics. Many researchers have attempted to determine the grade or age levels at which optimal learning of specific topics may be accomplished. Some investigators have attacked the problem by demonstrating a science principle to groups of children of varying ages and then testing them for comprehension. Others have studied children's remarks in free discussions centered around the topic in question.

The majority of these studies (and there have been many) point to one basic fact. It may be possible to place tentatively a given topic of science at a specific grade level. But it is virtually impossible to place a broad area of science at a definite age level. This means, for example, that while it may be impossible for first grade children to master an understanding of a given principle related to electricity, it does *not* indicate necessarily that they are incapable of understanding anything about the general topic of electricity.

In addition to age, the backgrounds, interests and geographical locations of children obviously must be considered in the selection of topics. Hence it might be suggested that attempts to "grade-place" science topics often waste the time and energy of the investigator.

Methods of Enriching the Curriculum

In modern teaching methods, much attention is given to the use of audio-visual aids, supplementary materials, field trips and other curriculum-enrichment devices. Science seems to be especially adaptable to such techniques. Hence, many studies

have been concerned with audio-visual aids and their relative merits for elementary science.

Many investigators have tried to determine, for example, how the use of films compares with field trips, or how radio programs and TV programs can be used in the classroom. All these studies point to one fact, namely, *all* methods of curriculum enrichment are valuable if properly used. While some methods are superior in given situations, in general they all have value at one time or another. In fact, the selective use of *many* techniques is probably most advantageous since it lends variety to teaching. The problem, therefore, is not which audio-visual aid is best, but the manner in which it may be used most effectively.

Teacher Training

Basic to all problems of status, curriculum, and teaching method is, of course, the problem of effective teaching. With the growth of elementary science has come a growing awareness that many elementary teachers are not adequately trained to teach science. As a result, they often avoid it.

This lack of training has been pointed out by many research studies that have dealt with the science backgrounds and competencies of elementary teachers. Almost without exception such studies have indicated that the vast majority of elementary teachers have had little or no science training. What little they do receive is often superficial or impractical and of little value in the elementary classroom situation.

Several studies have attempted to determine the reasons for these deficiencies. In general, it appears that prospective elementary teachers fail to take science courses because (1) their time is occupied with the many courses required for teacher certification and college graduation, (2) the requirements for certification and graduation demand little or no science; and (3) the courses in science offered for them are not of the general, survey-type they need.

SUMMARY

Obviously, no one can deny the value and importance of the emphasis on research in elementary science education in recent years. However, now that elementary science has "come into its own" as a topic of research, it might be well for future investigators to analyze critically the past research in an effort to improve future studies and to extend the earlier findings.

Perhaps the greatest fault with recent research in elementary science education has been its negative characteristics. Most studies have pointed out that many elementary teachers teach science at a level of mediocrity; lack proper equipment in their classrooms; and have insufficient science training. It would seem that further research of this type is redundant.

Hence, it might be well for future research workers to take a more positive attitude. Rather than attempting to determine how faulty the training of teachers

may be, it might be well to develop a satisfactory program with methods for implementing it. Rather than surveying the teaching methods most commonly employed, more study should be focused on the problem of how best to teach science in order to improve critical thinking and scientific attitudes. Further, much needs to be done on the problem of evaluation, rather than attempting to ascertain how poor present techniques are. This is especially true for the evaluation of skills and attitudes.

It would be most desirable for investigators to determine the developmental gradient in skills that represent the desirable outcomes of science instruction instead of trying to determine what specific topics of science should be introduced at certain grade levels.

Thus it would appear that, although research in elementary science education has progressed far in recent years, there is still much room for advancement.

HOW CAN THE ELEMENTARY SCIENCE PROGRAM REVEAL, NOURISH, AND MAINTAIN SCIENCE TALENT? *

N. ELDRED BINGHAM

University of Florida, Gainesville, Florida

IF the elementary science program is to reveal, nourish, and maintain science talent, it must be so organized that those boys and girls who possess aptitudes in science will have an opportunity for the expression and development of these aptitudes. We need researches to see how we can provide a situation where boys and girls may "live" the scientific approach in their classroom activities. Three phases of this appear significant to me: (1) How can we help boys and girls have fun with science? (2) How can we individualize in-

struction?, and (3) How can we develop critical mindedness?

How can we provide a situation where the boys and girls will have fun with science? Satisfying situations come from (1) actively sharing and planning what to do—children need an opportunity for individual and small group work with emphasis on projects; (2) discovering something new—for example, on a field trip with an able leader who takes students where, by questions, they come to logical conclusions about something as "how erosion takes place" or "how plants respond to light" or "how dunes are formed"; (3) confirming an idea—a student thinks something is true and improvises an experiment to demon-

* Paper presented at the National Association for Research in Science Teaching meeting, Teachers College, Columbia University, April 18, 1955.

strate that it is true, but which may prove the hypothesis false; (4) formulating an adequate explanation of some phenomena—for example, getting insight into how the phases of the moon are caused; (5) being able to investigate something at a time when one wishes to investigate something; (6) illustrating something one already knows, showing others something one has done—as in the case of the making of a working model of a steam engine; (7) interpreting some situation by means of principles or facts already known—for example, accounting for the dense thickets at the edge of a forest and for the absence of growth and vegetation in the dense forest; (8) seeing ways to use findings in new situations—for example, daydreams about buildings one will build or about the operation of a boat one is constructing; (9) having sufficient experiences with related ideas to come to a sound understanding.

On the contrary, dissatisfactions come from (1) always being told what to do and then made to do it—for example, a time schedule does not permit one to do what one wants to do when one wants to do it; (2) having no opportunities for discovery in a situation where there should be a chance to make discoveries—for example, the teacher erroneously draws all the conclusions about the experiment that is being done; (3) being forced to memorize facts without any opportunity to confirm these facts or to see the meaning as far as life is concerned; (4) always having the teacher, for example, presenting the facts and conclusions to be observed in a particular demonstration; (5) no opportunity to try things out—always expected to believe what the book says or what the teacher says; (6) no opportunity to illustrate one's own ideas; (7) no opportunity to interpret familiar situations in the light of new principles or facts; (8) no time for puttering or for daydreams; (9) having only superficial experiences.

Certainly boys and girls will have more fun with science if they have an oppor-

tunity to derive satisfaction from "living" the method of science. We need researches to find ways of increasing the number of satisfactions children can get from science in the elementary school program.

Instruction may be individualized in many ways. We need to find out about these—for example, many boys and girls will take responsibility by developing a science laboratory in a room. I know of one 5th grade in which the boys and girls organize every thing from tin cans to home made alcohol lamps. There is in this laboratory an environment for individual and group experiments when the rest of the class is otherwise occupied. This science laboratory provides a center for investigation. It nurtures the interest of the gifted children. It may include a zoo with aquarium and terrarium, and perhaps mammals and birds where the children care for living things. A second way to individualize instruction is to provide an opportunity for boys and girls with special interests to teach and demonstrate their findings to younger children. For example, I am thinking of a situation in which 5th grade boys were called upon to demonstrate magnetism to first grade children and they did an excellent job of it. On another occasion these same boys showed the fourth grade their weather instruments and talked about the anatomy of the air. Over a period of two years these same individuals have demonstrated the rotation of the earth and the revolution of the earth around the sun, to the kindergarten and grades one and two, with a planetarium which they constructed and built out of an erector set. We need researches to find ways to individualize the instruction.

Perhaps even more important than the two ideas already suggested is to find ways of developing critical mindedness on the part of the boys and girls. Boys and girls are frequently forced to spend their time memorizing what they have read, drawing conclusions from discussions, memorizing what the teacher has said, preparing to pass tests, with little emphasis upon deter-

mining whether the things that they are reading or being told are so and how they know they are so. I submit that critical mindedness can be developed by having children participate in determining what to do, that is, in determining the scope and sequence of the daily, weekly, and monthly program; in determining whether something is true or not; in discussing something in an informal atmosphere while children challenge the conclusions of others who are making unfounded statements or

where they challenge false conclusions drawn by demonstrators.

We need to know more ways of helping children have more fun with science. They will have more fun with science if they gain satisfaction from their experiences with it. They will gain satisfactions if they have an opportunity to help as individuals or in small groups and if they are stimulated to be critical minded regarding what they do, what they are told, and the conclusions that they draw.

HOW CAN SCIENCE LEARNINGS BE INCORPORATED INTO THE ELEMENTARY SCHOOL CURRICULUM? *

PAUL E. BLACKWOOD

Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

IN order for children to acquire significant science learnings at school, it is important, in the long run, that their teachers have a growing sympathy and understanding of the place of science in the lives of children. Therefore, elementary school staffs must develop a clear understanding of the purposes to be achieved by teaching science. One way for teachers to develop some agreements on the purposes for teaching science is to discuss it. The very question of this topic, "How can science learnings be included in the elementary school curriculum?", should be discussed by teachers, using whatever expert resources are available.

Individual teachers in a school may have a clear and well-developed point of view about teaching science. If others do not have an equivalent understanding, the efforts of some may be undermined by the lack of understanding of others.

Through discussions, school staffs will usually come to agree that science teaching

is not simply the transference of accumulated factual knowledge from books to the heads of children. They will see that science teaching is a means of helping children gain knowledge for themselves through methods of inquiry appropriate to them. And as teachers see the importance of helping children increase their skills in problem solving, in answering questions, in finding out things for themselves, they are well on their way to including science learnings in the curriculum.

Helping children learn how to learn, how to acquire accurate information about the world, is a primary purpose of many teachers. Acceptance of this purpose frees elementary teachers from the awesome task of transmitting information (which they often do not possess or understand) to children.

As teachers come to understand that teaching elementary science implies helping children to develop creative, yet reliable ways of acquiring and testing knowledge, they are in the best position to include science learnings in the curriculum.

Without this understanding, there is a

* Paper presented at the National Association for Research in Science Teaching meeting, Teachers College, Columbia University, April 18, 1955.

grave danger not only that teachers do not teach science but that they actually promote in children the development of unscientific opinions, disinterest in science, and indeed, non-scientific methods of acquiring and testing knowledge. Perhaps we need research along this line: To what extent and in what ways do teachers directly and indirectly introduce non- and anti-scientific methods and procedures as they presume to be teaching science? And, conversely, how and to what extent can teachers actually teach positive, constructive and scientific attitudes and methods even though not consciously labeling it "science?"

Science learnings can be incorporated into the curriculum by teachers who take into full account certain well known characteristics of children and how they learn. Children tend to be investigators; they learn better when they have a part in planning the things to be studied and the methods to be used; they learn in many different ways; they learn through direct, as well as through indirect methods. These are just a few examples of what we know about children and how they learn. If a teacher wholeheartedly takes these things into account

in working with children science learnings will emerge.

Another way to assure that science learnings get into the curriculum is for teachers and children to select for study areas of living in which children encounter immediate problems or have current, attention-consuming interests. If questions and problems "worth their salt" are chosen for investigation there will certainly be science learnings in them. Elementary teachers who do not see the possibilities of introducing science experiences into the program even when there are rich potential possibilities, should seek help from their principals, their supervisors and from other teachers. This type of initial inquiry on the part of teachers who desire to improve their teaching, but who recognize their limitations, may become the basis for a significant inservice program on science teaching. In the long run, if science learnings are to be a part of the total elementary school program, there need to be many opportunities for teachers to acquire experiences and skills which, in turn, enable them to help children gain science learnings and skills.

GROUP DISCUSSIONS *

BOOKS IN AN ACTIVE PROGRAM OF SCIENCE

CLARK HUBLER

Wheelock College, Boston, Massachusetts

FOLLOWING an address by R. Will Burnett, a panel of authors carried on a spirited discussion regarding the use of books in elementary science. All members of the panel were authors of science books for children.

The chairman, Glenn Blough, began with a question: "What will books and reading do in an active program that other undertakings can not do?"

* Panel Discussions, National Council for Elementary Science, The Conrad Hilton Hotel, Chicago, March 5, 1955.

But the discussion really became animated when Morris Meister, reacting to the preceding address, said, "Burnett reconciled spontaneity and coherence by giving a special definition of coherence. The use of books helps to bring coherence into the teaching of science."

Kenneth Freeman said he agreed: "We must avoid moving from one highly structured way of teaching to another that is equally structured. I don't believe there is any one way to teach science. Books can help children choose from their many in-

terests those activities that are worthwhile. The books need not be read mechanically from one end to the other, but neither should we depend entirely on the spontaneity of the children. Books can help with coherence."

"A good teacher can teach as Burnett described," Helen MacCracken conceded, "But even experienced teachers need some kind of a pattern to follow. Books can help to provide that pattern. A teacher should evaluate the books chosen in terms of the situation. We have many good books today to choose from, but teaching does require some kind of a pattern."

"As Burnett has said, the main element in science is spontaneity," Sister Aquinas pointed out. "Yet books help the untrained teacher to become a good teacher and as she teaches she will learn more and more the value of spontaneity. Text books must be highly flexible to serve as a guide, yet give definite help to those who need it. Even an experienced teacher needs suggestions. An activity must suit the situation: Limited funds, the locality, class size, the facilities, group differences—all help determine the kind of activity that will be desirable. One group hatched and raised chickens as the basis for many valuable learnings. If we rely on books too much, we destroy spontaneity."

"It is from books we learn what others have done," Meister cautioned. "We should be careful not to eschew the value of books as sources of information and stimulation. In many cases, books fire the imagination and raise problems to be solved. There are functions that only books can perform. In our drive for spontaneity we should not overlook their value."

"Burnett also said books should be used," MacCracken noted.

"But he qualified their use," replied Freeman. "It is no longer necessary to disregard content as such. I am not arguing for rigidity, but suggest that not all classes

need study birds year after year when the first robin appears in the spring."

"But you wouldn't care to go on record as opposed to robins," Blough suggested lightly.

Sister Aquinas said, "We should decide whether we want an entirely pupil-planned and directed program, or should others have a hand? In one case the children studied transportation in the first grade, and again in the second, third, and fourth."

Blough said, "Books have a prominent place in any science program. The books may serve as a point of departure, may provide information, and help to give coherence. With books children can check the validity of their own discoveries. Books should be used to do what can't be done as well in any other way."

Morris Meister observed that in many ways the situation in science education has changed but little since 1918: "Science is still struggling for a place in the curriculum. We still have great enthusiasm for extremes. We set up straw men and knock them down from either view. The solution lies in neither direction. We can start with books and develop spontaneity, or from spontaneity can turn to books."

Helen MacCracken said, "Children at various levels and situations have certain needs. The teacher is handicapped unless helpful reference materials at the level needed can be found."

"Books do not try to dictate the program," said Sister Aquinas. "In books we project ideas and expect spontaneity to pick up there. In an active program there is more reason than ever for supplementary books."

In conclusion, Glenn Blough noted that much had been left unsaid, but he hoped the panel had got a discussion going for the various groups to continue that afternoon—and before the day was over, it became apparent that his hope was fully realized.

DEVELOPING A PROGRAM OF ACTIVE INVESTIGATION

ELIZABETH CUNNINGHAM

New Britain, Connecticut

THE key-note speaker's theme "Spontaneity and Coherence in Elementary Science Experiences" was enthusiastically received and created much debate in group three. We discussed how the logic of the subject could be developed coherently, yet children be given freedom to plan and to investigate their own environment. From this discussion came the thesis that learning can be fun if children have freedom to plan and to investigate. This would support the contention that the science taught should be chosen according to children's interests and needs.

For example, under guidance children may have freedom to plan and to investigate democratically by a simple problem-solving approach and a method of active investigation.

E.g. While a discussion was going on in one classroom about a neighbor near the school, a Mr. Anderson, who had some hives of honeybees over at his house from which he was anticipating getting honey to eat; one of the youngsters reported that Mr. Anderson told him that on a sunny day about half of each hive of bees is out getting honey from flowers.

The teacher of this group of youngsters asked, "Do bees really get honey as we eat it from flowers?"

A child asked, "Then what do they gather?"

Another wanted to know, "Does this hurt the flowers?"

The teacher followed their interest with the question, "How can we find out?"

The children suggested a trip over to Mr. Anderson's, and it was arranged. They found books about bees. A great deal of active research took place. A honeybee was actually observed carrying pollen packed on his back legs.

Thus a unit of study was initiated by means of a problem-solving approach. Learning began when the pupils began to think. Their thinking started when they were not sure of what honeybees were collecting when visiting flowers. The teacher was wise to ask "How?" and "Why?"

So, to start a new unit or problem the teacher should first strive to motivate children so that they have questions which they want answered. The solving of one problem often leads to the investigation of another. Experience leads to experience. The alert teacher will be able to guide a child's interest in the return of the robin in spring to comparisons with other birds and animals. This may lead to a whole unit pertaining to conservation.

"How much pre-planning should a teacher do?" was asked in our group discussion. A need for sequence was expressed and also a need for planning with youngsters. It was felt that we owe to children a chance to share in planning. Coherence we need but we must not disregard the spark of spontaneity. By some it is felt that coherence in science activities needs not to be emphasized as much as coherence in the lives of the children—logic according to each child's interests and needs and abilities. Balance can be found in teacher-pupil planning.

The fundamental or elementary concepts should guide teachers in bringing about coherence. While studying astronomy, for instance, teachers may help develop basic concepts and sound scientific attitudes at each and any grade level. In an active program, the children increase the difficulty of problem-solving and research according to choice. The problems they choose, they believe important because they themselves select and evaluate them.

Teachers concerned more with coherent lives will not be so concerned by gaps in covering a prescribed curriculum. Covering a prescribed curriculum may be superficial as far as a large percentage of our children in our schools is concerned. Neither is covering a book real coverage and coherence. The type of environment

influences the learning experiences for a group of children in each classroom, in each school, and in each part of our large country.

Spontaneity is sapped from the science program by teacher-sponsored coherence. Teachers must help children to learn under their own steam. Flexibility in teacher pre-planning is superior. Coherence is brought about by the teacher in broadening experiences and by building significant understandings. The same subject areas may be taken at different grade levels and children will discover problems to solve with greater understanding and do research at higher levels as they progress.

In conclusion there can be the two dimensions—coherence and spontaneity—in ele-

mentary science experiences. We need both in balance. Coherence is brought about by the teacher in broadening activities and experiences and by building significant understandings. The use of books adds to coherence but they're only a tool of reference. Children need to be encouraged to do some thinking by the teacher's challenging questions, "How do we know?" "How can we find out?" There is need of this approach to answer the demands of democracy—the need for children to experience group participation and planning. In every classroom, every day, children want to know about everything from Atoms to Zebras. This is good, and in this age of science the study of science is a good thing.

WHAT CAN ADMINISTRATORS, SUPERVISORS, SPECIALISTS AND OTHER LEADERS DO TO AID IN DEVELOPING A PROGRAM OF ACTIVE INVESTIGATION IN ELEMENTARY SCIENCE?

MAMIE SPANGLER

Primary Supervisor, Lake County, Crown Point, Indiana

THE members of this group agreed that their function was not to develop a science curriculum to be handed out to teachers to follow. On the contrary, we accept the responsibility of working with teachers in constructing a science program based upon the needs of children in each school area, facilities at hand and local problems to be met. The program should be kept flexible to meet these needs. Administrators, supervisors and other leaders are responsible for in-service training and providing resources for teaching science including many different science books on various levels of difficulty.

We commend emerging science programs based upon spontaneous experiences such as the one reported from Louisville, Kentucky, by Dorothy Dreisback. As a result of a Science Fair, pupils proposed many questions which the teachers used in developing science units while producing their own resource units.

These resource units are now published in three very fine editions serving as the science program in the Louisville Schools. It suggests flexibility so that provision is made for many emerging units.

We were not concerned over the question of spontaneity and coherence as opposed to each other. Rather, we concluded that Persistent Life Situations provide coherence—that there is enough of related matter at the base or on the fringes of science experience to give coherence.

Sister Celine of St. John's College, Cleveland, explained a background course in science which she has worked out for teacher-training courses. She drew from all science fields materials that would be useful to teachers in giving them a feeling of security for teaching science. She also encouraged a great deal of experimenting on the part of student teachers so they would have security in this phase of teaching.

Herbert Montgomery of New Castle, Indiana, who has been active in school camping, discussed resources for science teaching. We were sorry to learn that his excellent camping program has been curtailed. The current stress of the 3'Rs has relegated this to the past. We hope he can soon resume. Many valuable learn-

ings come out of school camping and with the problem now of increased juvenile delinquency, we need to do more.

The group decided it is our function to promote the value of science teaching and to show that pupils who have rich science experiences in which other subjects are integrated do better in the 3'Rs.

HOW DO CHILDREN RESPOND TO AN ACTIVE PROGRAM OF SCIENCE?

BEATRICE M. MOORE

Muskegon Heights, Michigan

CHILDREN need guidance, the discussion group concluded. We can not depend on children to initiate questions. The good teacher will have plans prepared, even though the plans may have to be modified later. Spontaneity can be stimulated by the classroom environment and by questions the teacher asks. Teachers must be able to recognize and follow pupil leads and point them toward the teacher's objectives. There is need of a framework to guide the teacher and give coherence to instruction. Successful teachers do not evade the questions children ask, but use the "let's find out together" approach.

What do we mean by an active program? In a good program there is activity with

a purpose. The pupils discuss their problem, gather data through their own investigations. They experiment and draw conclusions. They use books, write creatively, use visual aids, community resources, and resource people. Observation can be active, and so can vicarious experiences. In an active program, children work enthusiastically, and they communicate their ideas to others. As the children work together and express their views, the teacher can tell whether or not they understand. A good teacher is always at work to get spontaneity; when the children really want to know, are curious, their response will be spontaneous.

CONSERVATION AND RESOURCE USE EDUCATION

ROBERT M. RING

THE meeting began with a presentation by Dr. Richard Weaver, University of Michigan, Mrs. Muriel Buschlein, Chicago Teachers College, and Ramon Swisher, Cook County Forest Preserve. Dr. Weaver discussed the need of urban conservation education and emphasized the idea that most conservation programs have been concentrating upon rural concepts. He discussed the matter of land use for in-

dustry, residential, services and recreational possibilities. He pointed out the interdependency of rural and urban areas.

Mrs. Buschlein presented the idea of developing a school resource file which might result from community surveys in which industries, organizations, parents, and lay people cooperate. She also gave emphasis to the need of better planning for field trips. In order that the specific

purpose of this educational technique might be achieved, she gave attention also to the importance of developing an understanding of the wise use of resources for the urban child before expanding the idea to one of regional or national scope.

Some of the significant statements gleaned from the general discussion follow:

(1) The improvement of community environment is important enough to be included as a school-day activity rather than as an after-school or weekend activity.

(2) School and community improvement activities should be reported and publicized in order that other schools may learn the techniques and evaluation for such activities.

(3) School environment might be greatly enriched by landscaping, with a variety of trees and other forms of vegetation, which might make possible a study of trees, insects, climate, etc. Back yard biology can be very effective, the use of city parks for school purposes might well be encouraged, school yards might well be provided with benches or seats where classes might meet for certain learnings which can be carried on more effectively out-of-doors.

(4) Other subjects than biology can be taught

out-of-doors. Outdoor Education rather than mere school camping is a means of providing broad learning experiences.

(5) The school drop-out problem should be explored in the light of outdoor educational opportunities. There appears to be no good reason to believe that all learning experiences are provided within the four walls of a classroom.

(6) The study of water resources with its many broad implications is important with reference to the use of land for both urban and rural life.

(7) Conservation is everybody's problem and cannot be confined entirely to any one area of learning. Concepts should be developed whenever the opportunity arises in any area of the curriculum.

Dr. Caldwell of Hammond gave a very interesting report of a school activity which involved the improvement of the school building and grounds.

Other instances of such activities were reported but it appeared to be the consensus of the group that not enough attention has been given in any schools to the problem of resource use.

CONCLUSIONS OF THE CONFERENCE

N. ELDRED BINGHAM

University of Florida, Gainesville, Florida

It has been pointed out that spontaneity and coherence are basically the same thing if instead of treating incidents opportunistically, they become the center of study. In such a situation the program is not planned by the students alone, but by the teacher and students working together. The logic is the logic of what is being done, of questions and solutions that come one after another. It is a scientific way of working together. Such a program makes use of many books and of a great variety of worthwhile activities. Principles and concepts are developed from observations, experiments, and other experiences. Explanations are ventured to account for what happened. The explanations become hypotheses to be tested to see if they harmonize with all of man's experiences. In the testing process new questions arise, and some of these are

selected cooperatively for further study by an individual, a small group, or a class.

We need not worry about gaps if teachers and children can communicate. Decisions are made together. Study will be directed toward problems that are challenging. What the students already know enters into the decisions. The children will not wish to be redundant.

There was some disagreement in the morning panel regarding the use of books. However all agreed that both text books and trade books can serve as the stimulus to students and teachers for all kinds of meaningful activities, that books can greatly extend the range of knowledge available to any given class group.

Perhaps the conference could be summed up by saying that the prospects for the future are dim if the teacher makes all the

decisions about what to study—bright if the program is planned cooperatively, if it is an emerging-type curriculum. The prospects are dim if the science program is dictated by any particular text book or course of study—bright if dictated by student enthusiasms, coupled with teacher guidance based on knowledge of students, of community, and the materials of instruction. They are dim if science is taught as a separate subject—bright if science becomes the basis for making all experiences

meaningful. The prospects are dim if teachers are not trained as individuals in their college teacher education program—bright if the individuals learn to cope with real problems and keep in contact with children all along the way. Prospects are dim if we provide limited materials and equipment, limited experiences in our teacher education programs—but bright if we keep the students surrounded with challenging books, assorted visual materials, experimental equipment, people, and ideas.

MEETINGS OF THE ASSOCIATION FOR THE EDUCATION OF TEACHERS IN SCIENCE, 1955 *

SPRING MEETING OF THE EASTERN SECTION

THE Eastern Section of the association held its 1955 spring meeting at the Connecticut State Teachers College at Willimantic on May 6 and 7. Highlights of the first day's program included visitation at the practice school conducted by Dr. William Forbes, discussion of the Willimantic science offering in the program of general education by Dr. Charles Prewitt, and discussion of the science offering in relation to the professional program by Dr. Robert Wickware.

The meetings of the second day included a symposium on "Problems of Water Use and Availability." The following papers were presented:

"Water Supply and Availability," by Professor George Maxey of the University of Connecticut.
 "Problems of Water Utilization and Pollution," by W. J. Snow, Water Engineer of the Connecticut State Water Commission.

"Effects on Fish and Game," by Douglas D. Moss, Aquatic Biologist of the Connecticut Board of Fisheries and Game.

Other features of the program were discussions of the elementary school science offering led by Dr. Harold Tannenbaum of the State University of New York College at New Paltz, and of secondary school sci-

ence led by Dr. David Blick of the University of Connecticut.

Institutions represented at this meeting included the Connecticut State Teachers Colleges at New Haven and Willimantic, the Massachusetts State Teachers College at Westfield, The Rhode Island College of Education, Rutgers University, the State University of New York Colleges at Albany, Buffalo, New Paltz and Plattsburg, Teachers College, Columbia University, and the University of Connecticut.

SPRING MEETING OF THE MIDWEST SECTION

The spring meeting of the Midwest Section was held at Iowa State Teachers College on May 12-14, 1955. Arrangements for the meeting were made by Dr. Dorothy C. Matala and Dr. Leonard Winier. The keynote address was given by Dr. Julian Greenlee of Florida State University, who spoke on "Effective Learning Through Science Investigations," and emphasized the conclusion that scientific methods of investigation constitute a natural method of learning that should play a part in instruction at all levels.

Three other presentations at this meeting were concerned with the role which television plays as an educational medium. Dr. Wendell Bragonnier of Iowa State College discussed "Stimulating Interest in Sci-

* Reported by F. L. Fitzpatrick, in part from notes supplied by Matthew Brennan, John C. Wells, Carmen Sanguinetti and Leonard Winier.

ence Through Television." Dr. H. C. Harshbarger of the State University of Iowa addressed the conference on the "Use of Television to Extend the Size of a College Classroom." Mr. Herbert V. Hake of Iowa State Teachers College gave a paper on "Television for Schooltime Use."

Five discussion groups were organized. Three of these groups considered science investigations and research activities as means of stimulating student interest. The other two groups centered attention upon problems of interesting college science majors in teaching careers, and methods of enhancing interest in science through general education programs.

Colleges and universities represented at the Midwest meeting included Drake University, Grinnell College, Indiana State Teachers College, Indiana University, Iowa State College, Iowa State Teachers College, Luther College, Platteville State College (Wisconsin), St. Mary's College (Minnesota), State University of Florida, State University of Iowa, University of Illinois, University of Nebraska, University of Wisconsin, Waldorf College, Wartburg College, and Wisconsin State College.

THE ANNUAL MEETING

The annual meeting was held at Teachers College, Columbia University on November 3-5, 1955, with Professor Ned Bryan of Rutgers University presiding. Primary emphasis was upon science and society, with particular attention to science manpower needs and the growing shortage of competent secondary school science teachers. At the general sessions, papers were presented as follows:

"Science Teachers, Industry, and National Defense," by Professor F. L. Fitzpatrick, Teachers College, Columbia University.

"The Gifted Student and the Science Program," by Dr. Miriam L. Goldberg, Horace Mann-Lincoln Institute of Teachers College

"Methods of Cooperation between Industry and Education in Science Teaching," by Dr. Harvey Russell, American Cyanamid Company.

"Identification of Students with Science Potential," by Dr. Sylvia Neivert, Bay Ridge High School.

Three discussion groups were constituted as follows:

1. *The Recruitment of Science Teachers*, with Dr. Ellis Haworth of Wilson Teachers College as Chairman, Dr. Matthew Brennan as Secretary, and Dr. Charles W. Prewitt of the Connecticut State Teachers College at Willimantic as Reporter.

2. *The Education of Science Teachers*, with Dr. Francis J. Rio of Connecticut State Teachers College at New Britain as Chairman, Dr. John C. Wells of Madison College as Secretary, and Alfred Ravelli of Teachers College, Columbia University as Reporter.

3. *Developing and Maintaining the Science Interests of Students*, with Dr. Elsa Meder of the Houghton Mifflin Company as Chairman, Mrs. Carmen Sanguinetti of the Puerto Rican Study, New York City Board of Education as Secretary, and Dr. Murl C. Shawver of Madison College as Reporter.

Reports of the discussion groups were made at the final general session. It was indicated that the problem of developing a superior corps of science teachers involved three phases: (a) identification of individuals having good potential, (b) motivating these individuals to become science teachers, and (c) making the career of secondary school science teaching more attractive. It was generally conceded that the potential science teacher should be identified while he is still a student in the secondary school, and that he must receive effective counseling as he proceeds with his training program.

As to motivation it was suggested that improvement over existing conditions was dependent upon better economic and social status, and more satisfactory working conditions for science teachers. With respect to social status it was urged that the teachers themselves must show evidence of intellectual development and social mobility, and that they must establish liaison with professional schools, community leaders, business, industry, professional groups, and modern media of communication with the

public. By way of improving working conditions it was recommended that the laboratory hour be recognized as the equivalent of the classroom teaching hour, that science classes and laboratories should not be limited in scheduling to late periods of the day when they conflict with various extracurricular activities, that the spirit of inquiry be fostered by placing less emphasis upon conformation to rigid courses of study, that more attention be given to the use of science resource individuals in the community, and that the science teacher be afforded time and encouragement to develop liaison relationships with professional groups in the community, and with industrial resources.

The process of identifying and fostering the science interests of students was seen as one which has many facets. Some clues come from the results of questionnaires and some from interviews. Teacher-student relationships in classes and the extent to which students exhibit a good background of science knowledge and methodology are other criteria. Further evidences are provided by students' out-of-school activities, their hobbies, and their reading habits. It was concluded that the teacher most likely to recognize and develop the science interests of students was the one who possesses a broad scientific background, the ability to determine student needs and concerns, and the faculty of providing a favorable climate for self-expression in the learning experience.

Problems of teacher education were recognized to include the fact that many college science programs are organized primarily for purposes other than the training of teachers, that too few college students major in the sciences, and that many of the strongest college science majors do not

elect teaching as a career. As is virtually traditional in such discussions, the respective merits of college courses in science organized in terms of (a) topics or principles, and (b) problems, was argued pro and con. There was general agreement, however, that the effective science teacher must have a good grasp of the subject matter, a sound understanding of the scientific approach to problem solving, and an enthusiasm for teaching.

At this annual meeting representatives of the following colleges and universities were in attendance: City College of New York, Connecticut State Teachers Colleges at New Britain and Willimantic, Coppin State Teachers College of Maryland, Fordham University, Madison College of Virginia, New Jersey State Teachers Colleges at Montclair and Paterson, Ohio State University, Pennsylvania State Teachers College at Edinboro, Rutgers University, Teachers College, Columbia University, St. Thomas Aquinas College, State University of New York Teachers Colleges at Buffalo, New Paltz, and Plattsburg, and Wilson Teachers College of Washington, D. C.

Officers of the association for the following year are as follows:

President: Dr. John Wells, Madison College
 President-Elect: Dr. Robert Wickware, Connecticut State Teachers College at Willimantic
 Vice-President (Eastern Section): Dr. June Lewis, University of New York S. T. C. at Plattsburg
 Vice-President (Midwest Section): Dr. Sylvan Mikelson, Ohio State University
 Secretary-Treasurer: Dr. Willard Jacobson, Teachers College, Columbia University.

Executive Committee:

Dr. F. L. Fitzpatrick, Teachers College, Columbia University
 Dr. P. L. Whitacre, Indiana University
 The President, President-Elect, and Secretary-Treasurer

METHODS OF COOPERATION BETWEEN INDUSTRY AND EDUCATION IN SCIENCE TEACHING *

HARVEY R. RUSSELL

Coordinator of Education Cooperation, American Cyanamid Company, New York, New York

IN recent years the concept of community centered education has gained considerable support in educational fields. This is particularly useful in the teaching of science where the contributions and the achievements of applied science in our industrial empires have been so successful. For many years science teachers have made good use of the industrial resources of their communities and the management personnel of these industries has welcomed such cooperation. With the growing concern on both the part of industry and of science education people for the improvement and strengthening of science education, efforts have been made to discover new and useful techniques and to integrate these techniques into a consistent program of industry education cooperation. Your speaker became interested in this problem a number of years ago and undertook a study of these methods of cooperation to see what had been done. Out of this study emerged some 11 different general methods which seem to have been used and an experimental trial in a nearby community of using the various methods of cooperation.

In the course of the above mentioned study reference was made to the work of Mort, Beach and others of this College in evaluating the quality of education. Their findings indicated that participation by the community in the solution of its education problems, is a measure of the quality of education which that community receives. Using this scale of participation as a measurement of quality, the several methods are discussed below in decreasing order of participation required.

Let us now turn our attention to a discussion of the methods. The first method is

*A talk delivered to the Association for the Education of Teachers in Science, November 4, 1955, Teachers College, Columbia University, New York.

that of joint committees of scientists and educators. These committees are concerned with problems of mutual interest. For example, in the Pearl River, New York High School at the present time there is a committee of scientists from the Lederle Laboratories of American Cyanamid and of science faculty members from the Pearl River High School who meet regularly to discuss problems in the teaching of science. The scientists are required to keep their eyes open for various "gadgets" which they use in their work that involves the simple principles of science which could be of interest and of use to the teachers and their students. For their part, the teachers are requested to keep their eyes open to problems and questions which could be answered more completely possibly by the scientists. The ramification of these discussions with its inevitable involvement in educational philosophy and in science has proven very useful and stimulating to all parties concerned.

The second method is that of cooperative education. This is a scheme whereby students use alternating terms of study on the campus and work in the field. This method of cooperation between industry and education has been spectacularly successful in good hands and thoroughly unsuccessful elsewhere. Probably the most noted practitioner of this type of work is Antioch College at Yellow Springs, Ohio, or Northeastern University at Boston, Massachusetts. Efforts have been made to use cooperative education at the high school level. One of the more interesting reports is that of the City of New York around 1920, as I recall, where the stipulation was made that such activity was to be reserved for students having an intelligence quotient less than 110. Cooperative education obviously has the advantage of supplying real

experience to the student as well as academic learning of the subject matter at hand. It is probably most susceptible to those studies which involve specific training and skill. One of the more promising uses of cooperative education is in the Junior College field. One should differentiate between cooperative education in which the control of the work phase of the program lies within the hands of the school and employment in which the control is in the hands of the employer. Cooperative education uses the work phase as an educational medium rather than a means of economic remuneration. Employment emphasizes the economic value primarily.

The third pattern is employment. This usually refers to part time and summer employment of teachers students and/or teachers and students in industry. Most of us have from time to time during our school careers worked at one kind of job or another, and are aware of the educational value of first hand experience. Employment permits not only that kind of experience but also very welcome financial remuneration which all of us need. As indicated above, this pattern places primary emphasis on the work done and the money that is paid for it. One real advantage of employment is that it is "real." There is nothing artificial about the kind of work done. If the production or if the service is adequately rendered then the remuneration is forthcoming; if it is not, then the remuneration is withheld. One of the difficulties of this pattern, however, is the labor laws in our various States which operate in various ways to limit the number of students who can use this type of employment. An important problem is to provide adequate supervision of jobs so as to prevent undue exploitation of young people. It should be said in connection with cooperative education that one of the difficulties is obtaining a coordinator who can successfully relate the interest of the industry, the school and the student in a working arrangement which fills the needs of all.

The fourth technique is that of field trips to industry. The use of field trips as an education technique is, of course, quite old. Unfortunately, many planned trips fail of their best possibilities because of inadequate preparation. In some cases people consider the plant trip to be somewhat of a frill or extra item on the educational scheme. On the other hand, there are those who are sincerely convinced that this is a very valuable technique and is as worthy of careful preparation as the classroom lecture or discussion. The difficulty is, of course, that it takes a good deal of work on the part of both the industrial and the academic personnel to make such a trip a useful educational technique. The teacher should in all cases be personally familiar with the facilities at the industrial establishment and should sit down wherever possible with the representatives of the industry to select those items which are within the comprehension of the student. He should then make some endeavor to prepare the students what to look for. The use of photographs and pictures whenever the industry can furnish them for this preview is often most useful. For its part, the industry should plan to provide some logical sequence of exhibits, provide sufficient guides so that groups do not exceed five or six people, certainly not more than ten. Guides should be chosen who have sufficient facility with words to be able to explain clearly and with enthusiasm the kind of equipment or operation which is being shown. Effort must be made to identify the scientific principles which are involved, at least the chief ones in any such equipment or operation. It would certainly seem worthwhile if this endeavor is to be used as an educational technique to have a follow-up, not necessarily an examination but some sort of check-up to make sure that understandings are clear and to measure the degree of learning which took place. Obviously, the elaborateness of these recommendations and the work involved is one of the reasons why planned trips are not more carefully done. It takes a good deal

of work and in the crowded schedule of teachers and industrial people this becomes a difficult matter. One should point out, however, that planned trips are fairly costly, particularly in hours of service required of both teachers and industrial personnel, therefore wise use of this investment seems to be necessary to justify the effort.

The fifth technique of cooperation is the use of speakers. This of course is a traditional method of supplying information to schools. Because of its general acceptance and its wide usefulness it is an excellent method. One must recall, however, that a speaker is essentially a showman and that the techniques of good theater should be fully employed to highlight the points of a speech. In scientific talks, the use of demonstration experiments is highly desirable. Considerable emphasis is put on this matter of good presentation by speakers because this part is often critical in determining the effect of the message, and it must be remembered that a good speaker can make a fine impression, but a poor one can make a very negative impression and one is worse off sometimes than if no speaker was used. There are many manuals on good speaking technique. Certainly all of them, I believe, stress the notion of simplifying and organizing ideas so that they follow a good and natural sequence, the use of contrasts, use of good lighting, proper use of a public address system, the use of contrast of speed and pace, pause, etc. While these points are clear to most of us, many of us tend to forget them.

The sixth technique is that of supplying technical information to teachers and students on request. This technique is the one which is suggested in the "50 Teachers to a Classroom" publication of the Metropolitan School Study Council of New York City. Essentially it means canvassing the community for resource people and then building a central file system by which these people can be located when needed. Your speaker believes that this is one of the most effective techniques, and certainly the most efficient of the techniques of coopera-

tion between industry and education. The reason for this belief is that it starts with the student's question and hence no extra motivation is necessary. Second, if properly used, the teacher gains considerable stature in the eyes of his students by his ability to tap competent resource people within the community. Thirdly, this method is effective because it makes good use of the expert's time and enables him to contribute to the public education in the field of his special competence. In our experience in working with the schools of the Stamford area, well over half of the cases handled were of this type. To recall to your mind how this technique works, a student in a class will raise a question which may not be immediately answerable by the resources of the classroom. The teacher or the student himself contacts the central information file. In the way we worked it, the teacher is supplied with postal cards previously addressed which the student can use to transmit his question to the person in charge of the information file. After the question has been edited (to define the inquiry, which is often an important job), it is referred to one of the experts in the field. An answer is obtained and returned to the school, either to the teacher or to the student. Frequently a telephone conversation takes place between the expert and the teacher and/or student and in some cases a subsequent conference has been arranged so that the subject and its ramifications can be thoroughly explored.

The seventh method of cooperation between industry and education is that of individual assistance services which includes assisting student projects and tutoring. This technique is very demanding of the time of the expert, but it is probably one of the best educational techniques we have. It should be used, however, only for those students who have unusual confidence and are in need of expert help. A few illustrations will indicate how this technique can be used. In one instance, a student was interested in building a working model of the electrolysis of sodium chloride.

He had little trouble in collecting the hydrogen and chlorine but to recover the sodium hydroxide produced in the reaction was somewhat more difficult. The expert who assisted this boy was actually a specialist in pharmaceutical chemistry but with a handy knack for understanding problems he suggested the use of an old refrigerator motor and pump connected backwards to be used to lower the pressure in the enclosed chamber and thus to boil off the water rapidly and to permit the recovery of the sodium hydroxide. This project was completed and won a first prize in one of the nearby Science Fairs. In another project a student attempted the growth of various fungi under different frequencies of light. He was assisted in building his apparatus and in establishing the correct frequency values of light by the use of photographic filters and in the isolation and culture of his organisms.

The question of tutoring may seem a little unusual. The ethics of teaching prevent a teacher from tutoring his own student. On such occasions teachers have frequently turned to us for assistance in tutoring students in Elementary Chemistry. In several instances where a previous year's graduate is having trouble with his College Freshman Chemistry members of our community and our chemical society have been of assistance in tutoring these students.

The eighth technique is not strictly a technique by itself, but a direction in which the various techniques may be used. It is vocational guidance. Such an endeavor uses speakers, printed aids, all the visual aids, demonstrations, personal consultation. Guidance ultimately has to be pretty much a personal relationship. The scheme which we believe to be effective is a general assembly presentation with a distribution of small generalized pamphlets. Later, after the invitations to consult with either the teacher or the speaker by students have been issued, a smaller group may meet to investigate the question further. At this point the use of planned trip may be indicated. Finally, individual consultations of

students with experts seem to provide a satisfactory way to do vocational guidance without overloading either industrial or school personnel.

The ninth technique is the use of printed materials, visual aids, and the like. This, of course, is possibly the best known of the techniques by which industry gives assistance to education. It has the tremendous advantage of mass coverage, but it falls short in not being a personal relationship which is often so valuable in educational work. Studies by Sinclair* of business sponsored teaching aids indicate that the most common fallacy which is encountered in this type of work is the failure to use words and pictures which are suitable for the age level at which the material is directed. This is particularly true with respect to reading difficulties. In the upper grades, however, like 11th or 12th, the dissemination of adult publications is useful. I am thinking particularly of technical publications such as *Chemical Engineer* and *Engineering News* which is written for a professional man but to one who is not a specialist these periodicals are often very stimulating because they give a sense of reality to the student. There is a danger of misinterpretation, particularly in controversial topics. Subject to this limitation, it is a very useful device. Possibly the most important thing about business sponsored teaching aids is that they should be used in conjunction but not as a substitution for other educational experience.

The tenth technique is that of radio and television. The great power of these new media of communication is manifest on all sides. Many of the remarks with regard to speakers apply here. The presentations should be well organized and well presented if they are to be effective. This, however, is pretty much an art in itself and comments on the technique of such broadcasting is not in order here. It should be

* Sinclair, Thomas J. *Business Sponsored Teaching Aids*—F. A. Owen Publishing Company, Dansville, New York, 1949.

pointed out, however, that these important media should never be forgotten and when feasible should be used both to spread the word about science, and also to use as instructional sources when the opportunity presents itself.

The eleventh technique is that of financial assistance. The provision of scholarships, fellowships, the gift or loan of equipment, sponsoring prizes, essay contests and the like, are all part of a pattern of financial assistance which is of great importance to the schools. These are well known techniques of long standing in the educational world. Valuable as they are, they do not actually relate to the direct learning or educational process. They do not make use of the community resources of information and therefore may tend to obscure the value of these other techniques. Certainly, no one would want to discourage the provision of financial assistance to schools because it is extremely valuable, but let us not permit its value to obscure the use of other techniques in education and industry cooperation.

In this recital of the 11 various general methods by which industry and education cooperation has taken place, the purpose

has been to expand the horizon of teachers and industrialists as to their opportunities for mutual assistance in the enrichment of the education of tomorrow's adults, and to suggest practical methods by which this enrichment may take place.¹ While many of the techniques are old and well known, the infinite variation which is possible on these several themes will make them adaptable to almost any community, no matter how small the local resources appear to be.

At American Cyanamid Company we are now planning a program of education cooperation which will include many of these principles and techniques. Our program is still in the planning stage and I cannot say now what the final result will be. It seems clear, however, that we shall try to take every advantage of the values of the partnership of practicing scientist and teacher as well as the more conventional techniques of printed materials and the like. We have every hope that this program will contribute its share to science education and to the general welfare.

¹ For a more detailed description see, Russell, Harvey R.: "Chemical Education in Our Business, Too," *Chemical Engineering News*, August 17, 1953. pp. 3358-3365.

TRENDS IN ELEMENTARY SCIENCE EDUCATION IN FLORIDA SCHOOLS

JULIAN GREENLEE

Florida State University, Tallahassee, Florida

IT seems important that personnel in a School of Education of a State University know whether the goals, that they accept as important, are consistent with those deemed significant by other leaders in the State's Educational System. Partly as a means of getting information, indicated above, a brief survey was made during the latter half of the school year, 1953-54.

This and other purposes of the survey are indicated as follows:

1. To determine whether representative objectives of instruction in elementary science edu-

cation are consistent with those deemed important by principals and supervisors in the elementary schools of Florida in which graduates of the School of Education of the Florida State University are/or may teach. (Designated hereafter as principals and supervisors.)

2. To determine whether, in the judgment of principals and supervisors, there is a trend toward more successful achievement of important objectives for children.
3. To determine whether principals and supervisors believe that science should be a definite, planned part of the program in the elementary schools.
4. To determine whether, in the judgment of principals and supervisors, there is an in-

creasing tendency to include science instruction as a definite part of the elementary school program.

5. To determine whether principals and supervisors believe that colleges of education are working effectively.
6. To determine whether principals and supervisors believe that teachers in service are taking advantage of opportunities to learn better ways of providing instruction in elementary schools.
7. To get information to serve as a basis for remarks, concerning trends in elementary science education in Florida Schools, to be made in a radio broadcast.

Implementing the Study

An instrument, including the items in Table I and a check sheet on which persons responding would indicate whether in their judgment the tendency was desirable or undesirable and whether it was increasing, decreasing, or remaining about the same, was prepared. On March 8 and 9, 1954, a copy of the instrument with an explanatory letter was mailed to each of the 869 principals and supervisors. The data, tabulated, was taken from an extensive, random sampling of 464 returns, received by March 27.

TABLE I

TRENDS IN ELEMENTARY SCIENCE EDUCATION, AS JUDGED BY PRINCIPALS AND SUPERVISORS OF ELEMENTARY SCHOOLS OF FLORIDA, IN WHICH GRADUATES OF THE SCHOOL OF EDUCATION OF FLORIDA STATE UNIVERSITY ARE OR MAY TEACH

	Percent judging desirability of item	*Percent judging tendency to be desirable	*Percent judging tendency to be undesirable	Percent estimating trend	*Percent believing tendency increasing	*Percent believing tendency about the same	*Percent believing tendency decreasing
1—Tendency to include elementary science as a definite part of the school program	97.4	95.5	4.5	94.8	77.2	20.9	1.8
2—Tendency to teach elementary science only by the use of incidents that come up	95.6	17.1	82.7	94.8	17.2	19.0	63.6
3—Tendency to use incidents when they may contribute to bringing an increased understanding of the environment	94.0	96.3	3.6	97.4	73.4	19.4	7.0
4—Tendency to depend on incidents that arise rather than having an over-all plan for instruction in elementary science	92.9	13.8	86.1	100.0	11.2	24.8	63.8
5—Tendency for new teachers to be better prepared to provide elementary science instruction	99.1	96.5	3.4	97.4	74.3	19.4	6.1
6—Tendency of Teacher Education Institutions to provide more practical instruction to teachers and prospective teachers	95.6	98.2	1.8	92.9	65.7	27.7	6.4
7—Tendency to provide children in the elementary school with science text books	99.1	93.0	6.9	98.2	67.5	27.1	5.2
8—Tendency to provide children in the elementary school with a variety of reference materials	100.0	98.2	1.7	95.6	80.1	17.1	2.7
9—Tendency on the part of teachers in-service to be aware of the values of elementary science as a definite part of the elementary school program	98.2	95.6	4.3	99.1	63.4	35.6	.8

* "Percent" indicates percentage of those judging item.

TABLE I (Continued)

	Percent judging desirability of item	*Percent judging tendency to be desirable	*Percent judging tendency to be undesirable	Percent esti- mating trend	*Percent believing tendency increasing	*Percent believing tendency about the same	*Percent believing tendency decreasing
10—Tendency on the part of teachers in-service to take advantage of opportunities to get help in learning better ways of providing elementary science instruction	100.0	97.4	2.5	94.8	49.0	48.2	2.7
11—Tendency on the part of school administrators to take the need for science instruction into consideration in planning for the construction of new classrooms	98.2	97.3	2.6	100.0	66.3	31.0	1.7
12—Tendency on the part of teachers to use materials and equipment appropriate for children rather than the conventional laboratory equipment	98.2	93.8	7.0	98.2	79.8	19.3	.8
13—Tendency to provide science in terms of meeting the children's needs rather than in terms of memorization of data and verbalization of principles that may be meaningless to children	99.1	98.2	1.7	100.0	74.1	25.0	.6
14—Tendency to teach so that learning is a continual thing rather than in such a manner that it starts and stops with the beginning and ending of the school day	98.2	95.6	4.3	98.2	69.3	28.9	1.7
15—Tendency to provide more opportunities for children to do experiments in such a manner that they can make discoveries for themselves	98.2	99.1	.8	98.2	62.2	36.8	.8
16—Tendency on the part of teachers to recognize the fact that attitudes are learned and that those being learned by the children are affected by all teaching	96.5	95.5	4.4	99.1	60.8	38.2	.8
17—Tendency to provide the children with opportunities to learn by experience the ways of working democratically	99.1	97.3	2.6	99.1	80.0	19.1	.8
18—Tendency to recognize the fact that democratic living calls for the acceptance of responsibilities as well as having freedom to make some choices for oneself	98.2	99.1	.8	99.1	73.9	23.4	2.6
19—Tendency to recognize the fact that the acceptance of responsibility places limitations on the freedom of the individual, thus putting the controls in the child rather than leaving all of them with the teacher	97.4	94.6	5.2	99.1	59.1	39.1	1.7

* "Percent" indicates percentage of those judging item.

TABLE I (Continued)

20—Tendency on the part of teachers to recognize the significance of the role that they play in determining the destiny of the children with whom they work	98.2	96.5	3.5	100.0	70.2	27.0	2.5
21—Tendency on the part of teachers to become more professional in that their objectives for the children play a larger part in determining their procedures	96.5	97.3	2.6	97.4	70.8	25.6	3.5
22—Tendency on the part of teachers to plan for and with the children in terms of the needs of the group rather than following the same routine for all groups	99.1	96.5	3.4	99.1	79.1	19.1	1.7
23—Tendency to make more use of community resources, including parents who have specialized information, in providing more meaningful instruction	98.2	95.6	4.3	99.1	68.7	26.8	4.3
24—Tendency on the part of teachers, taking courses, to enroll in those that will provide specific help instead of merely accumulating credits	97.4	98.2	1.7	97.4	77.0	20.3	2.6
25—Tendency to help children have experiences which will provide for integrated understandings rather than learning of isolated facts	94.5	95.4	4.5	97.4	70.0	27.4	2.6
26—Tendency to provide the children with a variety of types of experiences so that each child will have more stimulus as well as more opportunity to have a feeling of successful accomplishment	97.4	96.4	3.5	99.1	68.7	26.9	4.4
27—Tendency to stimulate competition for values that are real rather than competition, just to win the teacher's favor	98.2	71.7	28.0	94.0	59.6	35.7	4.5
28—Tendency on the part of teachers to recognize the fact that children are like they are due to the experiences that they have had and that instruction should be planned in terms of what the teachers and parents want the children to be like	92.2	69.1	30.8	95.6	45.9	31.6	22.5
29—Tendency on the part of teachers to plan instruction in such a way that children will be stimulated to develop new interests as well as relying on the children's manifested interests for leads as to what is appropriate	100.0	97.2	2.6	98.2	72.8	21.0	6.1
30—Tendency on the part of employing officials to recognize the importance of teachers being prepared to provide instruction in elementary science	98.2	95.6	4.3	99.1	40.8	56.5	2.6

Conclusions

The investigator found the immediate response gratifying. Actually over half of the persons to whom the questionnaire was sent, filled out and mailed the check sheet within a ten day period.

The responses (see Table I) lead the investigator to conclude that:

1. Representative objectives of instruction in elementary science are consistent with those deemed important by principals and supervisors in the elementary schools of Florida in which graduates of the School of Education of the Florida State University are/or may teach. (Designated hereafter as principals and supervisors.)
2. Principals and supervisors believe that there is a definite trend toward more successful achievement of important objectives for children in the elementary schools of Florida.

3. Principals and supervisors believe that science should be a definite, planned part of the instructional program in the elementary schools of Florida.

4. Principals and supervisors believe that there is an increasing tendency to include instructions in science as a definite part of the program in the elementary schools of Florida.

5. Principals and supervisors believe that Colleges of Education are "keeping up with the times," tending to provide more effective help for teachers.

6. Principals and supervisors believe that classroom teachers in service are taking advantage of opportunities to learn better ways of providing instruction in the elementary schools of Florida.

Addendum. Responses to items 27 and 28 seemed to be inconsistent with the others. This is perhaps due to the fact that a number of respondees thought the phrasing of the items to be ambiguous.

SCIENCE CLUB IN THE MAKING

GILBERT BENOWITZ

George W. Tilton Elementary School, Chicago, Illinois

"SQUEEZIE," "Foxy," "Tweedle-Dee-Dee," and "Frisky," are only a few of the animal names that are a part of my fifth grade class. The animal enrollment includes 3 Hamsters, 2 Parakeets, about 20 assorted Tropical Fish, 9 Goldfish, 2 Turtles, a Frog, a Newt, a Tiger Swallow Tail Butterfly, and many other casual insect, animal, bird, and fish visitors. This unusual gathering started when my class decided that they wanted to have a science club. Through the organization and growth of this club, many interesting and worthwhile learning situations developed.

At the start of the semester I asked the children if they were interested in forming a science club. The definite purposes and values for having such a club were then discussed. I explained that the club could take the place of the regular science periods, and that its main purpose would be to increase the class' interest in science. The children were enthused about the idea.

They felt it would give them a chance to share their hobbies and abilities.

The procedure for organizing a class club was outlined in the 5th grade English text which the class was using. Since many of the students had no previous club experience, a series of lessons were planned with the text, explaining the steps in starting a class club. These lessons included: Electing Officers, Duties of Officers, Commitments, Steps in Conducting a Meeting, and Secretary's Minutes.

The first meeting was soon held. A temporary chairman began the meeting with the nomination and election of a president, vice president, secretary, and treasurer. The club was also named "The Science Snoopers," and five cents a week was voted as club dues.

Tentative plans for organization were put into effect at the second meeting. The children's science interests were listed on the blackboard. The list included almost

every area of science and made us realize that only a trial approach could be used to decide what areas we were to study. The children discussed the subjects on the list again and managed to narrow the topics down to those subjects which held the most interest for the majority. Seven broad areas of science were finally chosen and each of the children voluntarily chose one of the areas in which to work. The children who had chosen the same area were grouped together as a committee. The committees included an insect committee, animal committee, inventors committee, adventure committee, tropical fish committee, plant committee, and a pre-historic life committee. The seven committees then met to elect a chairman and secretary for their groups.

The club proposed that these committees meet as experimental groups for one month. At the end of that time a new organizational procedure might follow depending upon what had happened during the month. The club also made a list of activities that would be required of each of the groups. These activities included a record of the committees' meetings, the making of a notebook by each person on the committee, and a committee project report and display to be shown at the end of the month.

At the third and subsequent meetings I met with each of the committees and helped guide them into workable areas of the field they had chosen to study. Each of the committees was started on a project. The Adventure Committee was preparing a flannel board play about famous explorers. The Tropical Fish Committee was making a three dimensional display of an aquarium. The Insect Committee was making water color murals of the life cycle of the butterfly. The Pre-Historic Committee was planning a cardboard television program. The Inventors Committee was making a fox-hole radio.

The 45 minute science periods on Monday, Wednesday, and Friday, were now used as club time. The Friday period was used for the club meeting. A part of the

Monday and Wednesday period was set aside for committee meetings. This time was also used by myself to acquaint the children with various techniques that they could use to make their reports interesting. One member of each committee was taught how to use the school's movie projector, film strip machines, and the tape recorder. The committees were also told that they could select films or film strips from the audio-visual catalogue which pertained to their area of study. I explained how their requests would be sent to the Department of Visual Education on a supplementary order. This training proved very worthwhile later in the year.

At the end of the first month, each of the committees made their project report. These reports consisted of display materials which were placed on exhibition around the room. The record of class committee meetings was also read to the club. The individual notebooks that had been made were put on exhibit.

When the final report had been made, the children asked to be regrouped. However, a new development occurred which proved itself the important second step in the club's development.

One of the main difficulties encountered by the committees throughout the first month was the lack of science materials and books in the classroom. This problem was discussed and acted upon at the next meeting.

To help solve this problem we joined the "Science Clubs of America" which sent us the "School Science Handbook." This booklet listed many places where students could write requesting free pamphlet materials. The "Chicago Schools Journal" science supplement issue of January-February 1953 was another source available which listed places where free science material could be obtained. A systematic check was made of the materials available in these books that would be helpful to the club. A letter was then composed by the class which could be used to send to any of the companies requesting their "free"

materials. Each of the children made a copy of the letter and were assigned several of the places we had chosen to write to. The letters were carefully checked for accuracy and then sent directly from school.

Within a short time all sorts of booklets, letters, wallcharts, comic science books, posters, and even model displays and filmstrips were sent to us. Information about aquariums, animals, rocks, insects, railroads, steel, conservation, all arrived without cost. The class continued to examine other educational publications where they found additional places to send for more free materials.

During this time I was also able to get sample copies of science textbooks at all grade levels from the textbook companies which were meeting at a convention in Chicago. Our Principal also contributed a variety of science texts to our growing collection. These texts contained material at every grade level so that every child in the class would be able to find information at their particular level of comprehension.

Our good fortune was further increased when one of the room parents donated a beautiful glass-covered bookcase to the room which was turned into a Science Library. Further contributions were made by the school librarian who gave us a set of encyclopedias, a set of Frances Parker's science booklets, and a large number of National Geographic Magazines which contained special science articles. One parent donated a Nature Atlas, and another parent, a subscription to the National Audubon Society. We were also receiving the Singer Science News and a weekly bulletin from the Conservation Department of the Cook County Forest Preserve District.

With this large amount of material at our disposal another bookcase was built and two tables were set aside to hold display material.

The second reorganization into committees occurred as the natural outgrowth of the club's interest in Tropical Fish. During their project report, the Tropical Fish Committee had brought several types

of tropical fish to school. These fish were placed in small fish bowls and put on the tables at the front of the room. The children were fascinated by the color, movement, and habits of these tropical fish. The idea of having room aquariums stocked with tropical fish was mentioned frequently at club meetings. As a result of this interest, the club organized to study Tropical Fish. The new committees formed were a Tropical Fish Selection and Identification Committee, An Aquarium Plant Committee, a Maintenance Committee, and an Inventors Committee.

Reference books about aquariums and tropical fish were gathered from the public library and purchased from pet stores. Each of the committees studied and listed the problems related to their part of the project. The first problem encountered was that the club treasury did not have enough money to buy the necessary aquarium equipment. I decided to ask for school help to solve the problem so a detailed list of the cost and types of aquarium equipment needed was prepared for the principal. I discussed the project with her and she consented to allow us the money (\$17.00) from the school fund. She also located two aquarium tanks (7 and 10 gallons) which were given to us. These two tanks and the money that had been allotted to the club provided the means for getting the project under way.

Each of the committees now had a practical problem to work on. The servicing of the aquariums was the work of the Maintenance Committee. This committee made a study of aquarium filtration and temperature control. Scale drawings were made of the equipment we had purchased to filter and heat the water, with the explanation of the mechanics of the equipment printed below the drawings.

The Inventors Committee had a representative from their group on each of the other committees. Their main function was to help cut down cost by thinking out new "Do It Yourself Ideas" that related to aquarium maintenance.



"Science Corners—Nature Nook"



"Pet Show"

The plant committee filled the tanks with the proper amount of gravel and water. This committee then purchased many types of aquarium plants which they planted in the tanks. Their selections were drawn in poster form with an explanation about each plants characteristics. The plant committee also brought in rocks and driftwood which were analyzed, and if accepted, placed into the tanks.

The fish for the tank were selected after an intensive study by the Selection and Identification Committee. Large charts were drawn identifying the main characteristics of each fish. These charts contained data such as the pictures of the fish, their common and scientific names, their breeding habits, disposition, livable temperature range, and their feeding habits. After this preparation a family of tropical fish were purchased and placed in the 10 gallon tank.

A similar study was made concerning Goldfish and the same procedure was used to stock the 7 gallon tank with a variety of goldfish.

The class also purchased a used 15 gallon tank which they decided to use for a terrarium. The project materialized very quickly. The tank was completely furnished with evergreen seedlings, moss, lichens, a forest floor of earth and sand, and

a small watery pond. The terrarium contained a newt, a frog, two turtles, and a small grass snake. Another small tank was used to house a crayfish.

The desire to acquire fish now passed into an equally strong desire to acquire some animals. A Golden Hamster was bought and placed in a cage donated to us by our school clerk. Two of the children also bought Hamsters of their own which they brought to school. With three Hamsters we were on our way to starting a miniature zoo. A few weeks later a parakeet was purchased. He was named Tweedle-Dee-Dee and seemed to fit in well with the others. By this time we had also collected several live butterflies which seemed perfectly at home in their wire inclosure. At intervals I allowed the children to bring their pets to school. Our visitors included a rabbit, a duck, several kittens, dogs, and parakeets.

During the collection of the "Children Aid," we received permission to have a pet show. All of the clubs' room and household pets were put on display. Over 600 children paid five cents to look at the animals. The affair was a huge success.

The animals prove themselves valuable in many other ways. The children enjoy writing stories about them. They have

learned how to use proper care in handling their own pets at home. The beauty of the aquariums, the chatter of the parakeets, the funny antics of the Hamsters and the devotion that the children show toward all of these pets has helped create an enjoyable room atmosphere. The children never seem to tire of looking at the fish or of holding the Hamsters when the opportunity presents itself.

Since the start of the club, the organization has changed many times. Sometimes the club organizes into committees, sometimes the club works on a project together. Independent projects are encouraged whenever possible. Interest in the club continues to grow. The children enjoy and appreciate the world of science because they have made themselves into a working part of that world.

INFORMATION SOURCES CHILDREN USE *

LAHRON H. SCHENKE

Drury College, Springfield, Missouri

THIS is a summary of a project which was an investigation of the sources of information children use for answering their questions and supporting their beliefs in science. Certain science areas were selected for discussion by children, the selection based on those areas in science which were believed to be familiar to first and second grade children. The selection of items to be included in the discussion was based, for the most part, on a list of science areas for the primary level by Craig.¹ As the children talked about these topics they were interrupted and asked where or how they learned what they just said.

The most significant work in relation to this project is the one by Bergen² who used two techniques in securing information concerning the sources of information children choose in relation to various types

of problems. They were running records of regular classroom sessions, and individual interviews in which children were asked a set of previously selected questions.

In the present study it was decided that a tape recorder would be used in gathering the data. A semi-nondirective interview was used in an attempt to avoid the containment feeling of a set of questions. It was thought that such a technique might prove more efficient as to indications of sources of information than classroom observation. (It was later found by trial classroom observation that children seldom indicate the source of their belief or information unless specifically asked for it. To ask for it in class then, would have been more upsetting than to ask for it during an interview.) To help develop a semi-nondirective interview technique the writings of Erickson³ and Axline⁴ were consulted. Both authors describe interviews of a non-directive nature, but in both instances for a different purpose than to determine sources of information children use. Their guidance was useful however. For example, Erickson warns of the danger

* Based on doctoral study "Information Sources Children Use" for Ed.D. degree at Teachers College, Columbia University, 1954.

¹ Gerald S. Craig. *Science for the Elementary-School Teacher*. Boston: Ginn and Company, 1947, pp. 527-530.

² Catherine M. Bergen. *Some Sources of Children's Science Information*, Contributions to Education No. 881. New York: Bureau of Publications, Teachers College, Columbia University, 1943.

³ C. E. Erickson. *The Counseling Interview*. New York: Prentice-Hall, Inc., 1950.

⁴ Virginia M. Axline. *Play Therapy*. Boston: Houghton Mifflin Company, 1947.

of jumping to early conclusions, of the restriction imposed when one asks questions with a yes or no answer, of the guiding effect of agreement or disagreement either by words or some other sign.⁵ Axline stresses the importance of the attitude of the interviewer, with kindness, patience, understanding, steadiness, and placing confidence in the pupil as the keys to a fruitful interview.⁶

The data for this study were gathered in an elementary school in Wisconsin, in a city of about 40,000 people. After permission for the study was granted by the school authorities, the first and second grade teachers were consulted and they selected children for the study. These teachers were urged to try to select as representative and typical group of children as possible. Following the selection the parents were asked for permission for their children to be interviewed.

Twenty two children were interviewed, nine in first grade, thirteen in second. Of the 9 from the first grade, four were boys and five were girls. Of the 13 from the second grade, four were boys and nine were girls. The average age of the first graders at the time of the interview was 7-2 (seven years, two months) and the average age of the second graders was 8-1. The average I.Q. of the children was 108.9 as determined by the California Mental Maturity Test. Seventeen of the children had a television set in their homes, four others were able to view television often enough so that it was a factor to be considered in their sources of information. The other child did not indicate television as a source of information during the interviews although she did say she sometimes saw television.

From a socio-economic standpoint, the children were quite similar, typical occupations of their fathers being factory workers, truck drivers, salesmen, sales clerks, tavern keepers, etc. The group included two whose parents held professional positions.

A schedule of interviews was set up so that each first grader was interviewed once a week and each second grader one or twice each week. The interviews were scheduled before school in the morning or after school in the afternoon for those who lived in the city. During the noon lunch period, nearly two hours long, those who came on buses and brought their lunches were interviewed. Before the interviews began all the children came in together for an explanation of the interviews to follow. Briefly, during this explanation the children were told that they would be given a chance to talk about various things related to science. They would be interrupted at times to find out if they remembered where they learned a particular fact or belief. If they remembered, they were to tell where they learned it; otherwise they were to feel free to say they didn't remember and it would be all right.⁷ They were also told that it was preferred that they not tell other children about the things talked about in the interviews, and that their talks would not affect their grades. Their teacher would not be informed as to how well they were doing or how well they behaved, and they were free to discontinue the interviews at any time they wished, without penalty. There were to be no rewards or punishment connected with the interviews.

The interviews took place in a vacant room with a tape recorder set up within easy reach of the interviewer and the microphone placed on the table between the interviewer and the child. It was originally thought that the tape recorder and microphone should be concealed, but since all the children were familiar with a tape recorder and its use from previous experience, concealment was deemed unnecessary.

All of the first grade children were interviewed at least five times and the second grade children nine times. The interviews

⁵ Erickson, p. 69.

⁶ Axline, p. 65.

⁷ It is estimated that the instances when the children did not remember the source varied between 10 and 40 per cent.

were directed or channeled as little as possible except to indicate the areas for discussion for each interview. These areas were quite broad or quite limited, depending on the particular areas of discussion and the child's knowledge of that area.

The main topics finally used for each interview are indicated below. The complete list differed for first and second grade, although the first grade list contained only items that were also found on the second grade list. In one interview the term "mammals" was not used because none of the children understood the word. They interpreted the word "animal" to mean mammal. It was not the purpose of these interviews to change or increase the knowledge of the children interviewed. It should also be explained that the children did not regard insects as being animals.

TOPICS FOR INTERVIEWS

1. Trees Birds
2. Animals (mammals) Insects
3. Electricity Weather
4. Plants Fish
5. Heat Fire Water Superstitions
6. Cars Trains Airplanes
7. Astronomy Optical instruments
8. Day and night Health
9. Protective coloration of living things
10. Optional—children's choice of topics (limited to science)

During the time when the children were in class or between interviews the tape recordings were played back and the pertinent parts of the interviews transcribed. It was a simple matter, once the interviews were typed, to read through the interviews and indicate the sources in the outer margin for ease in later tabulation.

The excerpt which follows, the beginning of the third interview with a second grade child, gives some idea how the interviews evolved.

I: Today I would like for you to begin by telling me what you know about electricity.

C: If a plug goes out sometimes the lights go off.

I: How do you know about that?

C: Cause our light went off and daddy had to go down and fuss around and we had to see by

candlelight. And once on our birthday a telephone pole came down and we had to have candlelight because the lights went out. The boys used flashlights and boy, we had fun.

I: Do you know where electricity comes from?

C: It comes along wires.

I: How do you know that?

C: Cause there's wires strung up, and I heard it on TV. They are strung up on poles and the steps are high up so you can't climb up there and get electrocuted.

It was necessary, especially during the early interviews, to ask probing questions concerning the sources. For example, when a child said he saw it in a book, he was questioned as to whether the book was a school book, his own book, or a library book. This meant that the source would be specific rather than general. The children soon became accustomed to indicate the specific source, and as the interviews went on they would usually say "a library book" or "a book at home" so that it became unnecessary to ask for further delineation of the source.

When the interviews were completed, a tabulation sheet was designed so that comparison and summary of results could be accomplished. One copy was used for each child. Later a number of these tabulation sheets, slightly modified, were used to get various summaries of the total results of the interviews. The tables which follow show some of the results.

In the analysis of the data it was found that nearly half, or 46 per cent of the sci-

TABLE I

PER CENT OF INDICATIONS FOR EACH SOURCE,
GROUPED INTO MAJOR AREAS

Major Areas	Per Cent
Direct Sources	46.0
School	8.8
People	22.8
Television	7.8
Radio	0.3
Commercial movies	1.9
Books	8.7
Comic Books	1.0
Others	3.0

TABLE II

TOTAL INDICATIONS FOR EACH SOURCE
EXPRESSED IN PER CENT

Source	Per Cent		
	First Grade	Second Grade	Both Grades
Direct:			
Personal observation	35.6	31.4	32.8
Individual experience	11.9	13.9	13.2
Secondary:			
School:			
Teacher	6.8	2.9	4.2
Class discussion	0.3	1.5	1.1
Classmates	0.7	0.6	0.6
Weekly Reader	1.9	0.6	1.0
Movies (at school)	3.3	1.1	1.9
Television	9.2	6.9	7.8
Radio	0.1	0.3	0.3
Church	0.3	0.2	0.2
Adult magazines	0.1	0.3	0.3
Newspapers	0.4	0.7	0.6
People:			
Father	4.7	7.9	6.8
Mother	7.9	7.7	7.8
Brother	1.1	3.7	3.1
Sister	1.1	1.9	1.6
Grandparents	1.1	0.9	0.9
Other relatives	0.4	0.4	0.4
Neighbors	2.2	2.3	2.2
Movies, commercial	2.5	1.5	1.9
Books:			
School	1.3	2.9	2.4
Library	0.9	4.6	3.4
Own, or in home	2.3	3.2	2.9
Comic books	0.5	1.3	1.0
Miscellaneous	2.8	1.3	1.6
Totals	99.4	99.8	100.0

ence knowledge of the children in this study was learned from direct sources; that is, by personal observation or individual experiences. In almost half the instances, then, these children learned their science knowledge and beliefs with no assistance other than incidental help from other people. This confirms the Bergen study which indicated that neither empirical nor authoritative sources were pre-

dominant, based on records of classroom sessions.⁸

The term direct sources as applied in this study refers to instances where a child: (1) sees something happen; (2) is involved in a thing happening; (3) has something happen to himself; (4) causes something to happen such as a test, trial, experiment, or experience.

Secondary sources as applied in this study refer to all sources not classified as direct. Secondary sources are all those in which someone else has had the use of direct or other sources, and by some means of communication has passed on the information. People can be a direct source if they are watched by a child, but people are a secondary source if they tell about what they are doing or have done.

A summary of findings based on this study is as follows:

1. The first and second grade children in this study had a wide knowledge of their physical environment.
2. There was a great variation among the children in this study in regard to their knowledge of science.
3. In this study there was no marked sex difference in the reference to sources of information.
4. The children in this study obtained their science information from a wide variety of sources.
5. In this study, nearly half the science information that had been learned by the children had been derived from direct sources; that is, by personal observation and individual experience of each child, and without the help of anyone else.

6. Based on percentages, the second most significant source of science knowledge and beliefs was other people. Of these, two-thirds of the responses referred to mother or father.

7. Nearly one out of ten responses indicated the school as the source of science information. Since children study science

⁸ Bergen, p. 63.

about one hour per week, but are viewing television, playing, etc. many more hours per week, this would seem to indicate that the school was a highly efficient source.

8. Books were indicated as a source by these children in 8.7 per cent of the responses. The responses of the first grade children for books was 4.5 per cent. Of the second grade children's responses, 10.7 per cent had been derived from books.

9. These children had gained an appreciable amount of science information from viewing television. Some of this information could not have been readily obtained in other ways.

10. Radio was very rarely mentioned as an information source in this study.

11. The children in this study did not, for the most part, seem to realize that, if the immediately available source did not furnish the wanted information, there might be other sources available. The source had to be near at hand, or it was not used.

12. The encouragement and example of an interest in science by parents and older siblings seemed to help to develop an early habit of using books as a source of science information.

13. Many of the children in this study had a critical attitude toward superstitions and fairy tale characters.

14. Comic books were an inefficient source of science information since most of the children in this study read several comic books each week but rarely mentioned comic books as a source.

15. The simple question, "How did you learn that?" when asked in an atmosphere of acceptance by the interviewer, elicited answers which revealed considerable depth of thinking and reasoning on the part of these children.

16. The tape recorder was very useful in getting the words of children exactly as expressed.

If most children are similar to the children in this study, then the following are

the more significant things for the elementary teacher. To begin with, children have a wide knowledge of their surroundings, and the sources used to learn any specific bit of information may vary from child to child. So the knowledge of the class as a whole will be wide; so wide that one of the best resources for teaching science in the elementary school will be the children themselves. They will, under proper guidance, also be able to evaluate the sources.

For the children in this study, the source used was usually the nearby source, the one most readily and easily available. It would seem highly desirable then to have resources and reference materials in the classroom and readily available for use by the children.

Older siblings, by example, are able to show younger children the usefulness of books as references and sources of information. Elementary teachers, knowing this, and having such younger children in their classrooms, can by like example have them show the way for the rest of the class.

There is some indication in this study that challenging questions may tend to lead children to turn to reference materials. If these reference materials are in the classroom the children could more readily learn to use such materials and rely on them.

Another point of significance for the elementary teacher is the technique of letting children talk in an atmosphere of acceptance by the teacher. Verbalization by the children may bring out science information and may also reveal how children think. These would help the teacher in teaching science more effectively.

Television is a source to be considered by the elementary teacher. The children in this study referred to it often as a source. It is possible that certain television programs can be used to bring out interests of children as a motivation for several days' study in science. It would probably be wise for the teacher to watch television herself to be acquainted with the next day's science interest! There will come a time too, when some child will indicate a dis-

like for a particular television program. With careful direction such a statement can be the basis for developing an evaluation of television programs by children.

SUGGESTIONS FOR FURTHER RESEARCH

1. A study parallel to this one with older children should be of value to get the picture of how the emphasis on the sources of information changes.

2. Would the percentages for each source change if some other field of knowledge such as social science, geography, or arithmetic were investigated in a similar manner?

3. How well do adults remember where they learned their knowledge of science?

4. Would the sources change if the children of different socio-economic levels were interviewed?

5. If the children in this study learned as much as they did from commercial television programs how much more could they learn from educational television? The question needs investigation. Is there a possibility that the children would learn very little more from educational television—that they are already getting nearly all they can and should from one educational medium?

ELEMENTARY SCHOOL SCIENCE—SOME PROBLEMS *

PETER C. GEGA

San Diego State College, San Diego, California

LIFE in the latter half of the Twentieth Century has grown very complex, and every indication seems to be that it will become even more so. By and large elementary schools have shown signs of taking the many new social problems in stride by the initiation of streamlined curricula and instructional methods. But has the science program been affected as widely as it should under these new circumstances? Many educators think not. It shall be the purpose of this article to survey briefly some of the shortcomings in the elementary program as we find it today and to suggest how the science curriculum can be brought closer to the needs of the child and his society.

The school code of California specifies a maximum of nineteen subjects which are to be taught in the elementary school. Sixteen of these subjects are obligatory and three are optional with the local school district. In the city of Los Angeles, Science, Spanish and Practical Arts are the three optional courses. Lately there has been some discussion of a measure to make the teaching of Spanish mandatory.

* Based on the author's Master's Thesis.

There is much evidence to show that the science program has received the same fleeting consideration in the elementary curriculum as it has gotten in the school code. Today the science program in most schools runs haphazardly on three cylinders while its more fortunate curriculum mates purr along on eight. Let us examine this situation at closer range.

First, there is the frequently found assumption that the teacher knows the scientific method and is acquainted with the basic laws and phenomena necessary to understand science at the elementary level. This assumption in many cases could not be more fallacious. Thousands of elementary teachers understand little of the *why* behind even commonplace phenomena. Lack of formal training in science helps to perpetuate this ignorance.

Everyone is acquainted with the timid adult who shrinks from a harmless spider or snake. Unfortunately, the grownup's fear is transmitted to the youngster who observes it. The example of the hysterical mother who draws the blinds and cowers in the closet with her children during an

electrical storm is not uncommon even today. The transmission of fear through ignorance is only one of the many vicious manifestations derived from the lack of scientific insight.

To make matters worse, the elementary teacher is expected not only to possess the necessary knowledge to conduct science classes, but is also expected to provide his own equipment. This affects the teacher and program in several ways. First, the teacher becomes a veritable scavenger as he combs the city for makeshift equipment—those things which he cannot find, he either buys (with funds from his own slim pocketbook) or omits from the science program entirely. The beginning teacher suffers especially because he has not yet had the opportunity to acquire some of the limited free materials available and does not possess the time to devote toward their acquisition. The harassed instructor, in his realization that he cannot find the time to procure abundant materials, becomes dependent upon the audio-visual department of his school system, which may send equipment, but invariably "too little and too late." Hence, the science program often tends to become nothing more than an observation of dead leaves, rocks, several domesticated animals, and assorted colored posters.

It will be patent from the following outline of the scientific method that the present science curricula have a long way to go. Scientific men generally agree on at least six steps as encompassing the method:

1. To conduct a survey of the general field and note major units.
2. To formulate the specific problem; to be followed by an orientation of the problem in terms of the general field of investigation.
3. To evaluate contributory material and sources of information.
4. To experiment. In the larger sense, to pursue new knowledge, recapitulate old knowledge, and accumulate data.
5. To summarize the results obtained from the procedure followed in step four; to compare results with known results in similar fields and with controls.
6. To formulate a conclusion or conclusions, based on steps one through five.

Let us consider the comparison of biological and physical science interests in the child. One observer found that elementary children prefer the physical sciences to the biological sciences because "... the former offer opportunities for exploration manipulation and mechanical activities."¹ The biological sciences as commonly taught offer little more than observation and very limited exploration to young children.

Elementary pupils seem to have little more than a mild and transitory interest in nature study after the initial discoveries and observations have been made. Slavson has pointed out the reason:

It is rather plain that the possibilities for a variety of "assembling" are limited in nature study; the materials of nature study are not flexible or plastic; the character of the material, animals or plants, is immutable and determined. The child's control over it is very small, and such control as he has is within very definite limits. He cannot change the living organisms by means of manipulation and experimentation to suit his imagination and to conform to the most important phase of his activity at that age: assembling. He can observe . . . (but) . . . the possibilities of creating new situations and causing new phenomena by reassembling materials and apparatus are lacking in biological work.²

This writer recalls an experiment conducted at the Thirty-Second Street School in Los Angeles. A need arose to demonstrate to the children the inadvisability of putting dirty objects in their mouths. The teacher secured several dishes containing nutrient agar and had the children contaminate the agar with the various objects. A control dish was not contaminated to show the children that the subsequent bacterial growth really did come from the assorted pencils, erasers, etc. that had been touched to the agar. When several days had elapsed and the bacteria had multiplied sufficiently, samples were scraped onto slides and examined under a microscope. As might be expected, chewing on pencils and fingernails came to an abrupt halt.

How can educators capitalize on the insatiable curiosity of the elementary school

¹ Slavson, S. R. and Speer, R. K. *Science in the New Education*, p. 122.

² *Ibid.*

child? First of all, *they must secure the necessary equipment*. The procurement of equipment will necessarily be difficult as long as many board members and educators maintain their present shortsighted attitude toward the elementary science program. It will be up to teachers and P.T.A. members and friends to make the beginning effort. Funds can be raised through the school organizations to buy science kits for individual schools. Some of these kits sell for as little as \$35.00. Committees of teachers and curriculum people could meet and draw up a list of materials available to teachers, *then procure and actually distribute these materials to the individual schools*.

It is apparent that a much better program can be worked out if the school's basic materials are stored in a central science workshop or laboratory and if classes can use the laboratory when the ordinary classroom is insufficient. This, of course, will meet with the opposition of many teachers who object to taking the children out of the classroom. It is difficult to understand why the establishment of a central laboratory in the elementary school has evoked so much unfavorable comment. Similar setups have worked quite successfully in several California communities, including Glendale, Burbank, Santa Monica and Long Beach. Indeed, from a financial standpoint, it would seem to be practically impossible to conduct a thorough science curriculum without one. Such common apparatus as a microscope, prisms, simple machines and dry cells, within financial reason if gotten on a school basis, become impossibly expensive if duplicated within separate classrooms. To pool as many resources as possible within the laboratory seems eminently more practical than to attempt a program on what materials each teacher can scavenge during odd moments.

This does not mean that the child and the teacher should ignore the possibility of procuring additional material—sometimes it is possible to find useful miscellaneous items offered by private sources. Also, the

resourcefulness of the children is exercised if a certain item of equipment is often not available. It does mean, however, that the school system should have the responsibility for getting *basic equipment, without which a sound, complete science program is virtually impossible*.

Unfortunately, no amount of equipment or funds will change the teaching of elementary science unless the teacher is sufficiently trained to lead his class with confidence. It is this writer's hypothesis that many teachers oppose the taking of the child from the classroom to the laboratory because it threatens the teacher's security. He is hesitant and unsure in a strange situation, he feels that his unfamiliarity with the equipment will be exposed before the class, that discipline will vanish.

Many educators have recognized the need for better teacher training in the sciences and have accordingly incorporated required fundamental courses in the undergraduate teachers' curricula. Numerous school districts have started science workshops, where teachers are given useful in-service instruction by competent supervisors.

One of the best ways to familiarize teachers with their science curriculum is to compile a good, easy-to-read handbook. Many handbooks "in use" today consist of little more than wordy, generalized statements which communicate almost nothing to the inexperienced instructor. Some science textbook writers tend to verbalize just as readily as some of their brethren in other educational fields, and, since science contains so many esoteric terms anyway, the wary teacher tries to avoid it as much as possible.

The science curriculum can more readily be made a dynamic enterprise which can produce definite results if it is continually conducted in terms of the following five specifics:

1. The development of scientific attitudes and the scientific method.
2. The needs of the child and society.
3. Correlation with other studies and life in general.
4. Fundamental instruction in *all* of the five

science fields, namely: astronomy, biology, chemistry, geology, physics.

5. The interests and experiences of the child.

Finally, this article does not mean to imply that observation of the various rocks, animals and plants does not have a very important place in the science program—of course it does; but let us not limit our

curriculum to this area alone and call it "science." Why should educators not take advantage of the tremendous interest engendered by children in all the other divisions of science? There is every indication that if we do, the child who says "I hate science" will become as extinct as the dodo bird.

PHYSICAL SCIENCE AND THE ELEMENTARY TEACHER

SAM ADAMS AND L. M. HARRISON

Louisiana State University, Baton Rouge, Louisiana

THE present situation in the sciences is best described as confused. At a time when such terms as fission, fusion, thermonuclear and supersonic frequently crop up in casual conversation, relatively few college students are entering the physical sciences. At a time when radio, TV, popular science publications and comic books impart to the young an odd miscellany of scientific information, many secondary students are satisfied if they meet minimum science requirements.

Yet those who are associated with smaller children would probably agree that these youngsters enter school with a great deal of scientific curiosity. An important question, therefore, is: What happens to this interest?

Some authorities take the position that shifts in interest are merely part of the growth process, and this would doubtless serve as a partial explanation. Others, however, insist that scientific interest is lost as a result of something that happens—or fails to happen—as the student advances through the elementary school.

One explanation frequently cited by elementary teachers is that science training, formerly limited to the secondary school, now begins in the lower elementary grades (in some schools the beginners have a science book), and that a great deal of dead-

ening repetition occurs in the elementary science courses. Another explanation, also frequently mentioned by elementary teachers, is that the college training they received simply did not equip them to do a satisfactory job as science teachers.

Along this latter line of reasoning, it appears that the amount of college science training required for elementary certification varies from 16 hours downward to zero. Many states require 6 hours, three of which would presumably be in a physical science.

Much has been said and written about the nature of the training in physical science which should be given to prospective elementary teachers. A few brave—but probably unrealistic—writers hold that these trainees should take some conventional college courses in chemistry, physics, and astronomy. However, many factors, not least of which is the already crowded condition of the elementary curriculum, rule out this possibility in most cases.

During the last two decades a pat answer has appeared on the scene. Largely under the sponsorship of "general education" advocates a fusion course including chemistry, physics, astronomy, geology, meteorology and maybe a few others—and usually called simply "physical science"—has experienced phenomenal growth. In many

programs, this is the only work in the physical sciences now being given to the elementary teachers.

On the basis of considerable experience with the physical science course, the authors are of the opinion that it probably serves well its original purpose, *i.e.* as a part of the general educational background of students whose proposed careers will be largely non-scientific in nature. However, we aren't sure that this course alone—three or six hours of it—can meet the needs of the elementary teacher.

In a recent physical science class in a liberal arts college, the following curricula were represented: pre-law, journalism, ministerial, music, business administration, secondary teachers in numerous fields, and elementary teachers. This latter group was unique in one major respect: all were prospective science teachers. Hence, their needs were definitely different from those of the other members of the class, who were taking the course for scientific background.

In short, the elementary teachers were thrown into a catch-all physical science course, which was not designed to help them in dealing with elementary science classes.

One prime goal of an elementary science class should be to preserve and nurture the scientific interests which the students have. This is very difficult to do if the teacher has to rely exclusively on the text. Yet the background training is such that many elementary teachers lack the confidence to attempt even a simple demonstration.

A possible way out might be to give

those in the elementary curriculum a separate course, centered around the elementary science texts, with a great deal of emphasis on the use of demonstrations and experiments based on simple household and school equipment.

One suggestion has been that, without setting up a separate course, one section of the physical science class might be established for elementary trainees. If, in the hurly-burly of college registration, this could be done, it might work well. Another idea has been to give the entire class the work needed by the elementary teachers. This course, however, would probably fall far short of meeting the general education goals of the other students.

Probably the most feasible approach would be to replace at least one semester of the present physical science course requirement with a "science for elementary teachers" course, centered around the ideas mentioned above. Such a course, when properly taught, could still make a contribution to the general education of the students. But its chief purpose should be to give help of a specific nature to those who will be teaching elementary science.

It is true that the physical science course grew rapidly—maybe because it was new, maybe because it sounded a little bit like a cure-all. But now that there has been time for a second look, many people in the field—administration and teachers alike—are wondering if this course, designed essentially as general education, is meeting the needs of those who will actually teach science in the elementary school.

BOOK REVIEWS

GREENLEE, JULIAN. *Teaching Science to Children*. Dubuque, Iowa: Wm. C. Brown Company, 1955. 185 P. \$3.00.

Teaching Science to Children is a revision of a source book first published in 1951. While this revised edition has been almost completely rewritten, it retains all of the desirable features of the very popular first edition. The book is to be used as a source book of science experiences for

teachers of young children. The author has attempted to put experiences in an order that is logical for children.

This book is written for the busy teacher who needs or desires help in teaching elementary science and needs material which can be understood after a single reading. The content, tables of contents, illustrations, bibliography, and index have been planned to this end. There are numer-

ous illustrations in black and white along the margins of each page that will be very helpful to the classroom teacher.

Content includes chapters on: Understanding Children, Children Investigate Substances, Mechanics, Heat, Living Things, Sounds, Rocks and Soils, Electricity and Magnetism, Air and Weather, Light, Water, and the Universe.

This is a book that teachers of elementary science will very much appreciate and will be referring to continuously. Its use will serve to help many a classroom teacher who needs practical classroom suggestions in teaching elementary school science.

The author is professor of elementary science teaching at Florida State University, Tallahassee, Florida. He is also Secretary-Treasurer of the *National Council for Elementary Science*.

CRAIG, GERALD S., ROCHE, RUTH LIPPENBERGER, NAVARRA, JOHN GABRIEL. *Experimenting in Science*. Boston (Statler Building): Ginn and Co. 1955. 288 P. \$2.60.

This is the sixth-grade book in the Craig *Science Today and Tomorrow* elementary science series. As with the other titles in the series, this book is equally attractive in format and appearance. The illustrations in color are superb, pertinent. The subject-matter seems most appropriate, carefully selected as to pupil needs and interests. Real, vital science content written in most readable literary style, and a carefully selected vocabulary should make this an almost ideal science book for the sixth grade boys and girls. In the series as a whole, there is a proper balance among the various sciences and a planned repetition of given topics from grade to grade but not a repetition in actual content.

When one reviews an outstanding elementary science series like the Craig series and other recent comparable series, one can but wonder if the ultimate has not just about been reached in so far as attractiveness, pupil appeal, teachability, and well selected content are concerned. Elementary science books are so much better by all standards of evaluation than they were two or so decades ago, or even a decade.

NAVARRA, JOHN GABRIEL. *The Development of Scientific Concepts in a Young Child*. New York (525 West 12th Street): Bureau of Publications, Teachers College, 1955. 147 P. \$3.25.

This is a doctoral study completed at Teachers College, Columbia University. This study explores the process and factors involved as an individual child learns about his physical environment. The method of research is uniquely valuable for the study of concept formation: continuous, long-term observation of a child one knows, fully detailed recording, constant evaluation and analysis based not only on objective knowledge and logical inference, but also on intuitive insight.

Altogether this is an exceptionally fine study which will be reported in more detail in a future issue of *Science Education*.

CRAIG, GERALD S. AND BRYAN, BERNICE C. *Science and You*. Boston (Statler Building): Ginn and Company, 1955. 63 P. \$0.88.

Science and You is the primer of the Craig elementary science series *Science Today and Tomorrow*. Many of the series have been previously reviewed in *Science Education*. The primer consists solely of appealing and striking pictures in color, all relating to some specific aspect of science. These are: Feel and Find Out, Things That Float, Kinds of Animals, Where Animals Live, Sounds, Seeds, Wheels, Changes in the Weather, and Heat and Cold Make Changes.

SCHNEIDER, HERMAN AND NINA. *Science In Your Life; Science in Our Life; Science for Today and Tomorrow*. Boston (285 Columbus Avenue): D. C. Heath and Company, 1955. 314 P., 346 P., 378 P. \$2.28; \$2.36; and \$2.44.

The above three titles in the *Heath Elementary Science* are for the fourth, fifth and sixth grades respectively. The texts for the first three grades have been previously reviewed in *Science Education*.

This is truly an outstanding series of elementary science readers—beautiful in format and well-selected science content, most effectively written. The literary style is most readable, warm, personal, and careful attention has been given to the vocabulary. The authors are noted leaders in the elementary science field and have written numerous science books for elementary school-age boys and girls. There is a balanced selection from the various science areas. The real needs of children have been taken into consideration in the selection of the content. The content is integrated with other subjects in so far as possible. A rich program of science activities has been provided. The strikingly beautiful illustrations present pictorially a science concept as it appears in the textual material.

There are suggestions of things to talk about, things to do, things to find out, and experiments. Yes, boys and girls can learn real science by using this series of books, and be fascinated in the learning! Undoubtedly this series will have a long and extensive usage.

BLOUGH, GLENN O. *Lookout for the Forest*. New York (330 West 42nd Street): Whittlesey House, McGraw-Hill Book Company, 1955. 48 P.

This is a book on conservation told in a dramatically interesting story form that will be enjoyed by boys and girls. They will see how the forests grow; how Ted's father and other forest farmers do their part to keep the forest healthy so that it continues to grow the lumber needed by all, distribute the rainfall, and serve as a source of enjoyment for everyone. There is an exciting trip to the forest ranger's look-out tower.

The illustrations in color by Jeanne Bendick, as always, are attractive and very important to the textual material. Her illustrations almost assure an outstanding book and as combined in

this case with a noted science writer, you have a combination hard to beat. This combination has produced the earlier *The Tree on the Road to Turntown, Not Only for Ducks, and Wait for the Sunshine*.

Professor Blough is associated with the University of Maryland and was formerly Specialist in Elementary Science in the U. S. Office of Education.

This is a highly recommended book for the elementary science book shelf.

SCHWARTZ, JULIUS. *Through the Magnifying Glass*. New York (330 West 42nd Street): Whittlesey House, McGraw-Hill Book Company, 1954. 142 P. \$2.50.

Professor Glenn O. Blough, well-known specialist in elementary science is quoted as saying "If I could have only one piece of scientific apparatus to use with children, I would choose a magnifying glass." This book gives plenty of fascinating uses for one.

The book tells about lenses and how to use them, things right around you (skin deep, fingertip signatures, crystal jewels), plants (the onion, pipes in plants, roots, flowers, life in the dust), animals (sap on legs, a hundred pearls, rings on their scales), man-made objects (hidden letters, pictures from dots, seeing sound, coiled coils).

Illustrations in black and white are by that outstanding illustrator Jeanne Bendick. The author has taught science in New York City public schools for twenty-five years and is author of the widely used high school biology text *Adventures in Biology* and the book for young readers *Its Fun to Know Why*.

This is a recommended book for the elementary science, general science, or biology book shelf. Elementary teachers will learn many things they can do with a magnifying glass.

KIERAN, JOHN. *An Introduction to Trees*. New York (575 Madison Avenue): Hanover House. 78 P. \$2.95.

In all of nature it is most difficult to find something more lovely than a tree. And no book has ever pictured them in lovelier colors than you find here. Both the writer and the illustrator must love trees as does the reviewer, to have caught the magnificent beauty here described and pictured. The illustrations are in vivid colors by Michael H. Bevans. The textual material is just as appropriate! Together, what a wonderful introduction to 100 of Americas best known and most beautiful trees.

And the author's first rule to know the trees is: Look at them. Look closely at the bark, the leaf, the flower, the fruit, and when the leaves are off, look at the leaf scars—the "fingerprints" of lost foliage—and the buds that promise new leaves "when Spring comes North again this year." Many trees may have only one distinct characteristic needed to identify them.

This is one of the finest books a school library—elementary, junior high, or secondary—could

have. Or for any elementary teacher or anyone else who loves trees!

STUART, JESSE. *A Penny's Worth of Character*. New York (330 West 42nd Street): Whittlesey House, McGraw-Hill Book Company, 1955. 62 P. \$1.75.

Shan lived on a farm and often had to go to the store to buy things for his mother. He liked to do this very much as he usually got some gum drops or chewing gum, or even a chocolate bar or lemon pop if there was a nickel left over.

One summer day he took some paper sacks to sell to the storekeeper. His mother told him not to take the one with the hole in it. But Shan needing ten sacks so he could get both a chocolate bar and a soda pop, slipped in the one with the hole. When Shan returned home his mother discovered what he had done and made Shan go all the way back to the store and tell what he had done. Shan felt so good for doing this in spite of his first misgivings and feeling so badly. He had earned a penny's worth of character.

This is really a fine book for primary children.

DEARBORN, WALTER F. AND JOHNSTON, PHILIP W. *Reading Kit*. New York (630 Fifth Avenue): Simon and Schuster, 1955. \$4.95.

Reading is the most controversial curricular problem today in American education. (Three other important non-curricular problems relate to segregation, teachers salaries, and lack of classroom space). At least a fair portion of the public so considers it and so do many teachers and administrators. Unfortunately, many of the latter two groups continue to blithely ignore the problem or counter the arguments with "Children today read better than ever." Surely many do—many more than in the past—population increases would assure this if nothing else. It may be, and probably is true, that a greater percentage do today. But why shouldn't they? Ought we not still be ashamed of the large percentage that cannot. While attention has been centered on reading—the same conditions apply to arithmetic, spelling and possibly less so to writing. However many college teachers are not so certain that spelling, writing, or arithmetic are any better off. There are too many parents, teachers, and administrators who believe the major function of the schools is "to make pupils happy." At any rate a lot of us find a lot of Johnny's who can't read even in college.

This reading kit should be of great value to parents and teachers in helping Johnny become a better reader. It is based on five years of testing by two noted authorities. It is especially adapted for home use. It should also help the teacher by supplying parents of slow readers with: (1) a scientifically balanced and proven set of the latest remedial aids that supplement the efforts of the school, and (2) an understanding of the whole problem as explained by the most competent educational authorities.

The kit contains: (1) *Helping Your Child to Better Reading Guidebook for Parents*, (2) *Word*

Baseball Game, (3) Superhighway Game, (4) Word Bingo, (5) Pinwheel Vocabulary Building Game, (6) 300 Sight Word Cards, (7) Stories and Games, (8) 300 Illustrated Word Book, (9) 80 Picture-Word Cards and (10) Picture Stamp Reading Book.

ZIM, HERBERT S. AND INGLE, LESTER. *Seashores*. New York (630 Fifth Avenue, Rockefeller Center): Simon and Schuster, 1955. 160 P. \$1.95.

Seashores is one of the outstandingly and deservedly popular *Golden Nature Guides*. It is a guide to shells, sea plants, shore birds and other natural features of the American Coasts. This is a picture key, there being 475 marine subjects in full color. These have been artistically and authentically done by Dorothea and Sy Barlowe.

The United States has about 54,000 miles of tidal shore line, nearly every mile a place of potential interest. This is the most compact, comprehensive, usable guide to marine shore life so far published. Elementary science teachers, biology teachers and students, and the amateur adult, boy, and girl, will be using it by the many thousands!

DODGE, NAT. N. AND ZIM, HERBERT S. *The American Southwest*. New York (Rockefeller Center): Simon and Schuster, 1955. 160 P. \$1.95.

This is the first in a series of guides to regions in the United States. The guide provides information to points of geographic and historical interest, essential information about the people, and characteristic land forms, plants, and animals of the Southwest. The guides suggest itineraries for numerous trips. There are more than 400 subjects in full color.

Much science is included in this guide. It is a fine reference for the geography teacher, the traveler and would-be traveler, and just as a general reference in the elementary school class-room library.

Mr. Dodge is a Regional Naturalist in the National Park Service and an authority on the Southwest. Dr. Zim is probably America's best known writer of science books for juveniles and guide books in science, guide books peculiarly suitable for elementary school teachers.

SYMPOSIUM. *A Program of Education for the Elementary School*. Towson, Maryland: Board of Education of Baltimore County. 53 P.

This bulletin is a curriculum guide for elementary school teachers. Developed by teachers and supervisors of the Baltimore County schools, the bulletin represents one of the outcomes of more than three years of study and evaluation of the program of elementary education in Baltimore County.

The result of this study has been one of the finest, most practical bulletins developed by any school group. The other two bulletins referred to in this issue of *Science Education* are equally outstanding.

This bulletin describes the foundations of the

program, its organization, and its operation. It lists functional areas of individual and group living, growth characteristics of children, suggested problems and experiences for various levels, and outcomes in terms of concepts, skills, attitudes, and appreciations.

Altogether this unusually fine bulletin represents a lot of planning, thinking, evaluation working, and writing. All of this may now be shared and put into practical use by not only the teachers of Baltimore County but by all elementary teachers across the land.

ZIM, HERBERT S. AND HOFFMEISTER, DONALD F. *Mammals*. New York (Rockefeller Center): Simon and Schuster, 1955. 160 P. \$1.95.

This is the seventh in a series of *Golden Nature Guides*. This guide portrays 218 animals in full color. With the illustrations, it is a clear, concise content on the various American mammals. For each specie there is a range map and family tree.

This is a fine guide for elementary school and biology teachers and pupils. The textual material is a rich resource book.

SYMPOSIUM. *Planning the Social Living Program*. Towson, Maryland: Board of Education of Baltimore County, 1954. 43 P.

This bulletin is an extension of the bulletin *A Program of Education for the Elementary School*. Its purpose is to guide the teacher in selecting problems to be taught; to indicate the possibilities for rich and appropriate experiences in their solution; to encourage teachers in the use of resource materials.

Grade placement of problems of social living are listed under each of six grades. Under each problem for each grade is listed a series of questions which indicate the scope of the problem, desired outcomes in terms of concepts, desired outcomes in terms of skills, attitudes, and appreciations; and relations to the nine areas of living. There is a chapter on preparation and use of resource materials.

SYMPOSIUM. *Food and Nutrition*. Towson, Maryland: Board of Education of Baltimore County. 1955. 80 P.

This pamphlet lists resource material for elementary school teachers in food and nutrition. There are ten units: Where Do We Get Our Food?, What Does Food Do For Us?, What Foods Should We Eat to Have a Well-balanced Diet?, How Can Food Be Prepared and Served to Make It Good to Eat?, How Do Eating Habits Make Our Meals More Enjoyable?, How Does the Body Digest and Use Food?, How Are Foods Preserved?, How Can Wise Buying Help Us to Get the Most for Our Food Dollar?, How Do We Depend Upon Others for Our Foods?, and How Do Foods and Food Customs of Other People Compare With Ours?

Each unit lists Scope, Understandings, Problems, Activities.

FREE AND INEXPENSIVE LEARNING MATERIALS.
Nashville, Tennessee: Division of Surveys and Field Services, George Peabody College for Teachers, 1956. 244 P. \$1.00.

This is the seventh edition of a book that has proved its great worth over a period of years. No entry is included unless it has been examined and evaluated. This edition contains 3833 entries: 1404 unchanged old entries; 1312 revised old entries, and 1117 new entries. Materials were evaluated on the basis of content, timeliness of subject matter, subject matter unbiased, and format.

The material is thoroughly indexed by topics, greatly facilitating usage of the material.

This is a recommended book for every school library and should be available to any teacher. Science teachers will find many free and inexpensive materials listed. Many teachers use it, but many more should.

WATSON, JANE WERNER. *The True Story of Smokey the Bear.* New York: Simon and Schuster, 1955. Unpagd. \$1.00.

Smokey the Bear is better known than David Crockett and is certainly doing more good. It is said that Smokey, the cinnamon-colored bear that looks down from the poster and says "Only You Can Prevent Forest Fires", is the most powerful force in stopping forest fires in the U. S. today. There are Smokey Teddy Bears, Smokey "T" shirts, dungarees, and belts, Smokey cookies, Smokey bubble baths, Smokey comics and Smokey stories. There are now over 500,000 Smokey Junior Fire Rangers and any youngster can join—free. "Smokey the Bear" is now kind of a trade name for the U. S. Forest Service.

Smokey is a real bear, living in a fire-proof home in the Washington, D. C. zoo.

This is the true story of Smokey beginning with his original home in New Mexico. Boys and girls will make this one of the most popular books on animal life ever printed. Every elemen-

tary school classroom should have a copy of this book—probably two or more—one copy will soon wear out! Pictures in color by Feodor Rojankovsky will be the center of attention for long hours at a time when the youngster gets his hand on this book!

MOORE, LILIAN. *The Golden Picture Book of Stories.* New York (Rockefeller Center): Simon and Schuster, 1955. 48 P. \$1.00.

This *Fun-to-Learn Golden Book* provides young children with many happy hours of reading and listening fun. Parents and teachers can read the stories aloud to children. Children will enjoy the 17 stories, many of them animal stories. There are also stories suggesting activities, riddles, and rhymes. The vocabulary is simple, and the sentences are short. Lively illustrations in color by Corinne Malvern not only help with the reading but also hold the children's interest. This is a fine book for the elementary school book shelf.

BROWNLEE, RAYMOND B.; FULLER, ROBERT W.; HANCOCK, WILLIAM J.; SOHON, MICHAEL D.; AND WHITSIT, JESSE E. *Laboratory Experiments in Chemistry.* Boston: Allyn and Bacon, 1954. 352 P.

This is one of the many revisions that this laboratory manual has had over many years. Old experiments that outlived their usefulness have been dropped and new experiments added. The student should learn to distinguish between what he *observes* and what he *concludes* from his observations. The one hundred eight experiments allows for considerable selection among experiments and the use of this manual with any high school text. There are a number of experiments in qualitative analysis.

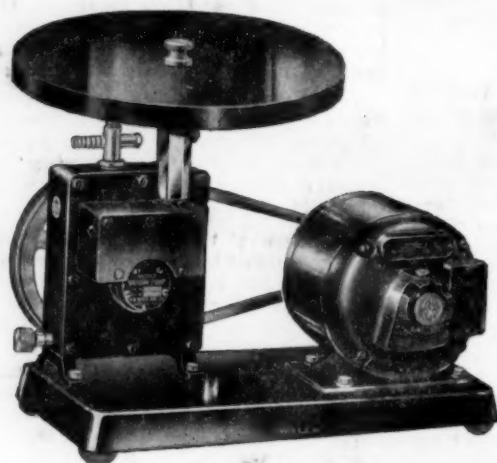
Probably more high school teachers and students have used this manual through the years than any other secondary school chemistry laboratory manual.

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